EDISON ELECTRIC INSTITUTE BULLETIN

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MAY, 1938

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DETROIT

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EDISON ELECTRIC INSTITUTE

STATISTICAL DATA OF THE ELECTRIC LIGHT AND POWER INDUSTRY

KILOWATTHOUR SALES (000's)

(Electric Light & Power Industry) **(By Major Classes of Service)** **(100% of Industry)**

Year 1937

State	Total	Farm	Residential	Commercial[a]	All Other
Total United States	**99,446,364**	**2,389,304**	**16,875,489**	**71,104,321**	**9,077,250**
Maine	672,163	12,209	93,554	542,756	23,644
New Hampshire	305,604	8,441	64,908	213,778	18,477
Vermont	208,307	7,493	43,918	151,819	5,077
Massachusetts	2,977,327	23,482	662,834	2,109,341	181,670
Rhode Island	554,315	3,239	94,606	440,995	15,475
Connecticut	1,456,475	27,480	323,241	1,028,693	77,061
New England	*6,174,191*	*82,344*	*1,283,061*	*4,487,382*	*321,404*
New York	13,511,103	87,401	2,073,310	9,711,123	1,639,269
New Jersey	3,070,594	24,007	640,527	2,246,143	159,917
Pennsylvania	10,075,185	84,670	1,431,186	7,229,326	1,330,003
Middle Atlantic	*26,656,882*	*196,078*	*4,145,023*	*19,186,592*	*3,129,189*
Ohio	6,945,292	74,350	1,140,613	5,155,088	575,241
Indiana	2,597,909	45,985	407,199	1,902,107	242,618
Illinois	7,307,560	48,537	1,262,575	4,636,170	1,360,278
Michigan	4,882,763	71,869	896,580	3,617,269	297,045
Wisconsin	2,043,641	52,972	443,166	1,450,672	96,831
East North Central	*23,777,165*	*293,713*	*4,150,133*	*16,761,306*	*2,572,013*
Minnesota	1,408,297	13,389	356,869	975,594	62,445
Iowa	1,163,781	29,923	256,276	817,555	60,027
Missouri	2,405,380	23,520	489,880	1,554,447	337,533
North Dakota	120,892	1,989	45,202	64,973	8,728
South Dakota	147,425	2,752	46,842	86,643	11,188
Nebraska	590,455	11,335	150,459	372,740	55,921
Kansas	961,261	18,134	187,509	708,856	46,762
West North Central	*6,797,491*	*101,042*	*1,533,037*	*4,580,808*	*582,604*
Delaware	201,484	2,052	33,557	149,175	16,700
Maryland and District of Columbia	2,293,442	17,915	389,989	1,496,790	388,748
Virginia	1,204,653	24,801	240,605	899,124	40,123
West Virginia	1,651,343	7,375	140,756	1,458,605	44,607
North Carolina	2,009,077	21,861	234,546	1,696,271	56,399
South Carolina	1,020,018	10,847	100,690	884,579	23,902
Georgia	1,550,622	19,199	240,879	1,260,172	30,372
Florida	734,715	14,828	239,607	430,596	49,684
South Atlantic	*10,665,354*	*118,878*	*1,620,629*	*8,275,312*	*650,535*
Kentucky	978,131	11,975	167,801	702,310	96,045
Tennessee	1,390,569	24,056	240,809	1,071,952	53,752
Alabama	1,595,179	19,913	173,280	1,383,539	18,447
Mississippi	389,471	9,176	68,311	288,568	23,416
East South Central	*4,353,350*	*65,120*	*650,201*	*3,446,369*	*191,660*
Arkansas	438,613	5,523	64,397	341,411	27,282
Louisiana	907,452	16,691	120,686	722,687	47,388
Oklahoma	989,956	17,949	157,068	760,442	54,497
Texas	2,858,644	33,104	484,045	2,084,069	257,426
West South Central	*5,194,665*	*73,267*	*826,196*	*3,908,609*	*386,593*
Montana	1,338,737	4,952	74,078	1,148,629	111,078
Idaho	529,422	32,034	96,138	397,090	4,160
Wyoming	94,260	1,626	21,685	66,956	3,993
Colorado	569,041	8,040	112,909	426,230	21,862
New Mexico	94,163	3,800	23,648	64,756	1,959
Arizona	500,866	106,898	44,969	333,333	15,666
Utah	782,424	17,153	81,685	649,959	33,627
Nevada	115,352	1,881	18,867	90,849	3,755
Mountain	*4,024,265*	*176,384*	*473,979*	*3,177,802*	*196,100*
Washington	2,428,407	78,869	479,321	1,638,480	231,737
Oregon	1,071,551	41,052	267,273	665,744	97,482
California	8,303,043	1,162,557	1,446,636	4,975,917	717,933
Pacific	*11,803,001*	*1,282,478*	*2,193,230*	*7,280,141*	*1,047,152*

[a] *Includes large and small light and power.*

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EDISON ELECTRIC INSTITUTE BULLETIN

Volume 6 MAY, 1938 No. 5

The Sixth Annual Convention

BEING just a little weary of the hard-worked superlatives used from time immemorial in ballyhooing conventions, we have decided to be reasonably honest about the Convention to be held at Atlantic City, June 6-9.

It certainly is not going to be the biggest one ever held by an electrical organization and it *may* not be the best, but we hope it will stack up pretty well with the good ones of the past. After all, the success of a Convention depends largely on the spirit and comradeship of those attending. Just another case of getting returns commensurate with the investment.

We want to emphasize that the Convention is not going to be an epoch making occasion, and all the problems of the industry are not going to be settled—neither are all the questions of importance going to be discussed, at least not on the platform—but there will be intelligent discussion of some of the more outstanding subjects of executive concern. These matters are of broadest interest rather than specialized discussions of particular matters of administration and operation, which are being successfully handled at the annual accounting, engineering and sales conferences and at the meetings of the several committees of the Institute.

The subjects will include power sales and profits; advertising and publicity as a component of public relations; analysis of electricity sales; accounting economies; building in the future for residential sales; trend of plant cost; ways to make customers like your company; customers and service; the outlook for private enterprise; the future for financing of private enterprise; fluorescent footcandles and kilowatthours; the two World's Fairs to be held next year.

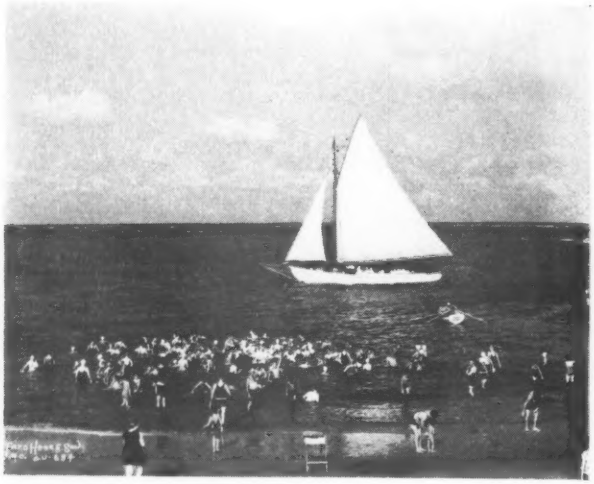
There will be only four business sessions, with a maximum of four speakers at any one session. No limit has been placed on the number of impromptu speakers at the banquet, but President Kellogg will keep the situation well in hand.

Concerning the speakers we can honestly say they are top-notchers in their fields (in fact just about the best we could locate for the occasion), fair to excellent talkers, and men whose judgments and opinions are respected.

The speakers include Messrs. C. W. Kellogg, President, Edison Electric Institute; J. E. Davidson, President, Nebraska Power Company; Dr. Virgil Jordan, President, The National Industrial Conference Board; Dr. W. W. Cumberland, Economist, Wellington & Company; W. H. Harrison, Vice-President and Chief Engineer in Charge of Department of Operation and Engineering, American Telephone and Telegraph Co.; Colonel John P. Hogan, Chief Engineer, New York World's Fair Corporation; Colonel J. Franklin Bell, Executive Vice-President, Golden Gate International Exposition; W. H. Sammis, Vice-President, Commonwealth and Southern Corporation; H. S. Metcalfe, Director of Public Relations, West Penn Power Company; H. A. Snow, Controller, The Detroit Edison Company; B. S. Rodey, Jr., Associate Controller, Consolidated Edison Company of New York, Inc.; D. M. De Bard, Vice-President, Stone & Webster Engineering Corp.; A. H. Kehoe, Vice-President, Consolidated Edison Company of New York, Inc.; and Ward Harrison, Director of Nela Park Engineering Department, General Electric Company.

Now, veteran convention-goers prob-

Convention Headquarters by Night



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ably know better than we the benefits to be derived from attending conventions. We hope that top executives will send as many of their key men and women as possible—as a reward for meritorious performances in the past, and for what they will get out of the foregathering.

What is expected to be a most pleasant feature of the Convention is the annual banquet to be held in the American Ballroom of the Hotel Traymore, Wednesday evening, June 8, when impromptu talks will be made by several notables of our industry. Professional entertainment will also be arranged by the capable committee which is looking after that phase of the Convention. The Entertainment Committee is headed by Mr. R. E. Swift of the Atlantic City Electric Company and includes the following gentlemen: Messrs. B. L. England, Benjamin F. Lee, F. Edwin Reiber, James J. Tynan, George M. Leach, Fred Ellenberg, Frederick Reiber, Harry E. Smith, Harold Stanton, William Hearing, Frank Collins, George Haney, C. Anderson and E. H. Knox.

It is recommended that reservations for the banquet be placed early since seating arrangements will be made in accordance with priority of reservations. This recommendation also applies to hotel reservations. While we are not going to pretend you can't get a hotel room at the last minute, you will have a chance for better accommodations by making your reservation early.

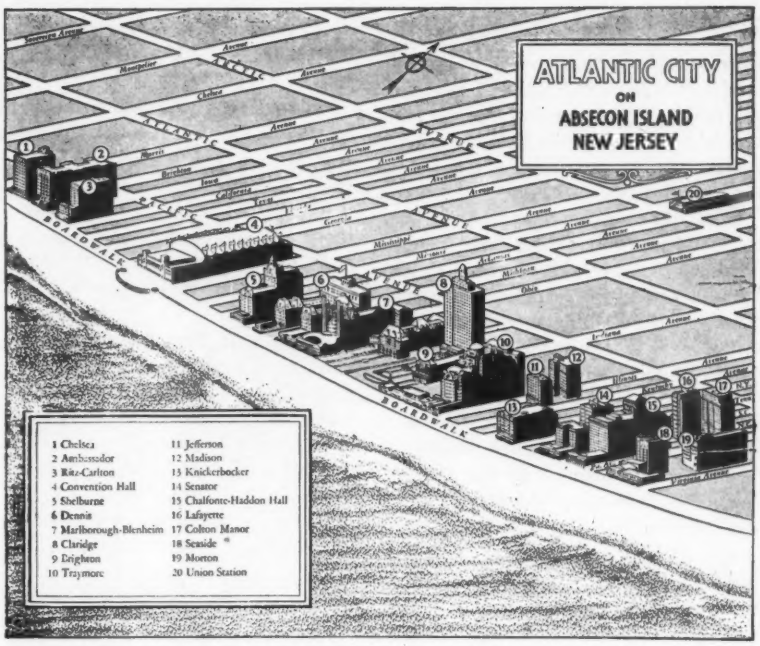
Headquarters of the Convention will be at the Atlantic City Convention Auditorium. While many will arrive the previous Saturday and Sunday, Monday, June 6, will see, we hope, the arrival of the bulk of delegates and their families and friends, registration, special committee meetings and scores of little reunions as old acquaintances are renewed, and utility men making their first appearance at the Convention are welcomed by the special Reception Committee with all the traditional hospitality that Atlantic City offers.

Monday evening the President's Reception takes place in the Rose Room of the Hotel Traymore. Here Convention delegates and guests will become better acquainted with each other and with the officers of the Institute and relax after what may have been, for many, a journey of several days.

First General Session

The first business session of the Convention will open Tuesday morning promptly at 9.30 with President Kellogg's address, in which he will discuss important problems confronting the industry. W. H. Sammis, Vice-President of The Commonwealth and Southern Corporation, the second speaker, will outline the sales approach to two important power sales problems—meeting competition, and directing the sales effort toward the profitable load. It is hardly necessary to emphasize that these two sales problems are of particular interest to every utility man in view of present conditions.

"Stones for David's Sling," is, we suspect, a deliberately intriguing title of an address of Mr. H. S. Metcalfe of West Penn Power Company, who follows Mr. Sammis. Mr. Metcalfe's address will deal with the whole question of advertising and publicity as a component in the solution of the public relations problem of the industry. He will be followed by Mr. Harry A. Snow, Controller of The Detroit Edison Company, who will present an analytical discussion of electricity sales. Mr. Snow has at his command a wealth of information on the power business, and his address should be of particular value.



Hotel and Convention Hall Location

Second General Session

Opening the Tuesday afternoon session, 2.30 promptly, will be B. S. Rodey, Jr., Chairman of the General Accounting Committee of the Institute and Associate Controller of Consolidated Edison Co. of New York, Inc. His topic will be "Possible Accounting Economies." He will discuss the factors that have tended directly and indirectly to increase accounting costs and will point out means of partly offsetting this tendency.

Mr. Davis M. DeBard, second speaker at this session, is Chairman of the Institute's General Sales Committee and Vice-President of Stone & Webster Service Corporation. Mr. DeBard's address, "Building for the Future in Residential Sales," will review the present outlook for retail sales and suggest possibilities for the future.

Third speaker at this session will be Mr. A. H. Kehoe, Vice-President of the Institute and Vice-President of Consolidated Edison Company of New York, Inc. Mr. Kehoe will speak on the "Cost of Plant," discussing past and present trends of such costs. Mr. J. E. Davidson, the final speaker at this session, takes as his subject "Ten Ways to Make Your Customer Like Your Company."

Third General Session

Wednesday morning, time 9.45, will bring the report of the Nominating Committee, the election of Trustees and special announcements concerning the New York and Golden Gate World's Fairs. Colonel John P. Hogan, chief engineer for the former, Colonel J. Franklin Bell, executive vice-president of the latter, will be the speakers. The

Convention will then be addressed by W. H. Harrison, Vice-President of the American Telephone and Telegraph Company, who will discuss "Customers and Service" and outline some of the principles applied by the Bell Telephone System to this vital phase of all public utility operations.

Ward Harrison of the General Electric Company will be the final speaker at this session. He will discuss the place that fluorescent lamps may be expected to take in the lighting field in the near future, and will present a display of fluorescent lamp applications.

Banquet

No formal session is scheduled for Wednesday afternoon. At the banquet Wednesday evening at the Hotel Traymore presentation of the Charles A. Coffin Award will be made, and the winners of the George A. Hughes, the Curtis, the Thomas W. Martin and National Water Heating Council Prizes will be announced and will receive the awards. As noted elsewhere there will be impromptu talks by notables of the industry, and special entertainment provided by professional talent. Later the gathering will adjourn to the Rose Room of the Traymore for an entertainment program and dancing.

Fourth General Session

Thursday morning, 9.45, will see the closing session of the Convention. The Byllesby, Forbes, Lindemann and McGraw individual awards will be announced by Mr. H. P. Liversidge, Chairman of the Prize Awards Committee, and presented by the several donors. Dr. Virgil Jordan, President of the National Industrial Conference Board, and nationally known economist, will discuss the outlook for private enterprise in America. His address should be of marked significance for every delegate. The next address to be given by Dr. W. W. Cumberland, partner of Wellington & Company, should be of equal interest. Dr. Cumberland, an economist whose background includes, in addition to his work with private industry, service as an expert with the U. S. Reparations and Financial Commission at Paris in 1919, advisory service to the U. S. Department of State, and financial consultant to a number of foreign countries, will speak on "The Future for Financing of Private Enterprise."

The introduction and installation of officers will be followed by adjournment of the Convention.

CONDENSED INFORMATION ON THE SIXTH ANNUAL CONVENTION

The convention headquarters will be located at the Atlantic City Convention Auditorium. The business sessions which will be held on Tuesday morning at 9.30 a.m.; Tuesday afternoon at 2.30 p.m.; Wednesday morning at 9.45 a.m., and Thursday morning at 9.45 a.m., will be held in the Ballroom of the Auditorium.

Advance registration will open at 10 a.m. on Monday morning, June 6, in the lobby of the Hotel Traymore. There will be no charge for registration but it is necessary to register to obtain the convention badge, program, etc. On Tuesday, Wednesday and Thursday the registration booth will be located on the main floor of the Convention Auditorium, and will remain open throughout the period of the convention.

Recreation

The President's reception will be held on Monday evening, June 6, in the Roseroom of the Hotel Traymore at 9.30 p.m., to be followed by dancing.

On Tuesday, June 7, a luncheon and Fashion Show will be given for the ladies in the Grillroom of the Ambassador Hotel at 1 p.m. A cordial invitation is extended to the delegates to bring their wives and daughters. There will be dancing in the Roseroom at 9 o'clock.

Banquet

The second annual banquet will be held in the American Ballroom of the Hotel Traymore on Wednesday evening, June 8 at 7.30 p.m. All those who have not done so are requested to send their reservations to Mr. E. A. Lewis, Vice-President and General Manager, Atlantic City Electric Company, Atlantic City, N. J., who is handling this affair. The price is $6.00 per person. Following the after-dinner speeches there will be entertainment and dancing in the Roseroom.

Hotels

A Circular giving rates and locations of the principal hotels in Atlantic City together with reservation blank has been sent to all members of the Institute. Reservations should be sent direct to the hotel of first choice.

This circular also contained information pertaining to transportation. In view of the reduced rates, no Identification Certificates have been issued to the Institute by the Railroads.

Special Meetings

Among the special meetings scheduled to take place in the course of the Convention is a luncheon meeting of the General Sales Committee on Monday. The Operating Committee will hold a luncheon meeting on Tuesday and the Board of Trustees will meet at luncheon on Wednesday.

Meetings of several accounting groups will be held on Monday, as noted below:

The Plant Accounting and Records Committee under Vice-Chairman J. V. Cleary will hold an all-day meeting beginning at 10.00 a.m.

Mr. K. E. Boyle, Chairman, will hold an informal meeting of the Customers Relations, Commercial Accounting and Collection Committee scheduled for 2.00 p.m.

Mr. C. S. Brock, Chairman of the Purchasing, Stores & Transportation Committee will likewise hold an informal meeting of his committee scheduled for 2.00 p.m.

Due to the death of Mr. F. P. Dexter, Chairman of the Classification of Accounts Committee, the scheduled plans for this meeting are not complete. Members of this committee will be advised later.

All of the above meetings will be held at the Hotel Traymore and are for committee members only.

The entertainment program includes the President's Reception at the Traymore to be followed by dancing. There will also be dancing Tuesday evening in the Rose Room of the same hotel, as well as dancing after the banquet Wednesday evening. A fashion show and luncheon is planed for the ladies attending the Convention. This affair will be held at 1 p.m. in the Grill Room of the Ambassador Hotel on Tuesday, June 7th.

Nothing has been said about the attractions of Atlantic City, first because most everybody has been there anyway, and second, if they haven't they have, without doubt, a pretty good idea what the place is like as a result of the publicity of the Atlantic City Convention Bureau and its other loyal boosters. We are nevertheless printing a few pictures of some Atlantic City scenes to give a little local color to this write-up.

"The Future of the Utilities"

By Thomas N. McCarter

President, Public Service Corporation of New Jersey

An address before the Eighteenth Annual Conference of the National Association of Mutual Savings Banks, May 4, 1938, Waldorf-Astoria, New York City

I RECALL with appreciation the very generous welcome which this conference extended to me three years ago when, as a spectator in attendance at one of your sessions, I was unexpectedly called upon to address you. At that time, I was President of the Edison Electric Institute and I recall with gratitude the helpful and courageous position taken by your Association in reference to the troubles that then surrounded our industry. Much has happened in that three-year period affecting the public utility industry. I come here today in no controversial spirit, but with a desire to lay before you certain basic facts, whether good or bad, which are founded upon my own experience, as well as upon long-continued observation of and familiarity with the doings of others. I shall avoid so far as possible the recitation of statistical information, as too many figures used in an address are difficult for an audience to absorb, but I shall refer to reliable sources of information which, upon investigation by those who are interested, will confirm many of the statements of facts hereinafter made.

It so happens that my experience includes three branches of public utilities, viz., the Electric business; the Gas business; and the Local Transportation business. I have had no personal experience of any moment in either the Railroad business, the Communication business, or that of Water supply. I appreciate that I am addressing managers of savings banks whose opportunity for investment in securities of utilities is closely restricted both as to the variety and seniority of utility securities in which they can invest.

Starting then with my own experience. The Local Transportation business, for the purposes of this address, may be dismissed with a few words. It has been and is a continual headache. The horse-drawn stage coach gave way to the horse car and the horse car was superseded by the cable car and the electric car, and the Electric Railway industry is now rapidly passing out and being supplanted by modern bus systems. My experience leads me to the

MR. McCARTER

statement that well-operated bus systems located in favorable communities, under proper regulation and without cutthroat competition, can earn a fair but not excessive return upon the amount of capital actually invested. The difficulty about it is that many of them are successors of former existing properties, the fixed charges of which they have inherited.

The Electric and Gas industry may be considered either jointly or separately, as many companies operate both, while others operate only the one or the other. If considered separately, the Electric business is the better of the two. If considered jointly, they complement and are mutually helpful to each other. The Gas business has had its vicissitudes. It is something over one hundred years old and began as an illuminant, succeeding the tallow candle and the oil lamp. The oncoming of electricity and the development of the incandescent lamp, after a period of years, practically destroyed the Gas business as an illuminant. But meanwhile the Gas companies, with commendable foresight, were developing a huge cooking business, which far more than overcame the loss of the illuminating business. That business still exists in large measure, although its full measure of growth is somewhat lessened by the changing habits of the people as to cooking and, once more, by the competition of electricity. Meanwhile the Gas business has been extended to large industrial use and is building up a very substantial house-heating business. But it must be remembered that these newer classes of business, while large in volume of business, are carried on at competitive prices and at cheaper rates than is the ordinary commercial business of such companies. Nevertheless the Gas business today is solid and substantial, and while not free from difficulties is dependable. It is a fact that during the year 1938 thus far elapsed our sendout of gas has increased whereas our output of electricity, and the number of riders upon our Transportation system has decreased.

The development of the Electric business in the last fifty-five years or thereabouts has been an economic marvel, until at the present time there is something over $13,000,000,000 legitimately invested in it. The savings banks of the country own a very large amount of the first mortgage bonds of these electric operating companies. The business done by these companies may be conveniently subdivided into four main classes of customers, viz.

1. Domestic or Residential service.
2. Commercial or store service, together with small power installations.
3. Public street lighting.
4. Industrial Power.

Except as influenced by present existing economic conditions, the growth in all branches of this business has been steady and continuous. And even now in the serious depression through which we are at the moment passing, the only loss that is felt is in the industrial power business, resulting from the lessened activity of manufacturing establishments. This particular service, large in volume but rendered at cheap and competitive prices, looms large in percentage decrease of generated kilowatts but not so seriously in Operating Revenue. Its effect upon the Electric business has been, generally speaking, to make the operating revenues of these companies during this immediate current period static—

that is to say, it has more or less negatived the increase in revenue arising from the other classes of customers. However, from 1929 to the end of 1937, the Electric Light and Power industry added 3,000,000 customers to its lines—or a gain of 12½ per cent. Energy production during this longer period of depression has increased 29 per cent—and gross revenue increased $242,000,000 or 12½ per cent, while the average annual consumption in the home in the same period has increased 67 per cent. What other comparable industry in this country can match this record? Dean John T. Madden and Professor H. B. Dorau of New York University have recently completed an exhaustive study, showing a percentage comparison between public utility securities and various other classes of corporations passing through receivership, or as to certain securities in default in the longer depression period from 1929 to date. Here are some of their comparisons:

Electric operating	1.6%
Manufactured gas operating	2.4%
Municipal bonds (in default)	5 to 10%
Railroads	21.7%
Foreign bonds (in default)	38.5%
Tractions	41.8%
Real estate (in default)	61.7%

The figures speak for themselves.

Another very illuminating article showing the marvelous manner in which high grade electric properties have withstood the depression and other troubles hereinafter referred to, is entitled "Public Utilities as Trust Investments," by Dr. Jules Backman, found on page 423 of the April issue of the publication "Trust Companies." Of the $13,000,000,000 invested in this business, something less than 50 per cent is represented by bonds, approximately 25 per cent in Preferred stocks; and the balance in Common stocks. It would appear that the financing has been conservative. In my own operating company, the Public Service Electric and Gas Company, bonds of Public Service Electric and Gas Company and securities of lessor companies represent 39.2 per cent of the capital; Preferred stocks—12.8 per cent; and Common stocks—48 per cent. Taking the country as a whole, less than 1 per cent of the senior securities of the operating companies have been in default during the depression; less than 10 per cent of the Preferred stocks were at any time in arrears on dividends. Even at the lowest point of the depression, the interest charges on the bonds of the operating electric companies have been earned twice over.

Now what are the "outs" about this business, if any? Well, here they are:

1. The general economic and political conditions prevailing all over the world, and in this country in particular. These conditions affect every industry and every individual in this country. I do not propose to discuss them in any detail. You all know what they are and are quite as competent to envisage their causes as I am.

2. For the last five years this industry has been the victim of a concentrated political attack upon it by the Federal Government of an unprecedented nature. The attack has brought in its train direct Government competition involving the investment by the Government of many hundreds of millions of dollars; municipal competition made possible by gifts and grants made by the Government to municipalities; the overdevelopment of regulation (no one objects to the exercise of proper regulation) until it has invaded the field of management. The multiplication of governmental bureaucratic agencies, superimposed upon state agencies, attempting to exercise detailed control over the affairs of these companies, if there be any hooks of interstate commerce connected with their operation, however small, upon which these governmental bureaus may hang their hat. Except for governmental assistance as above referred to, I do not think that the growth of municipal operation would be a very serious factor. The condition of the municipalities of this country would seem to indicate that they have enough to do to take care of their own multitudinous affairs without embarking upon new classes of business in which the municipal fathers have no experience, in addition to which the financial problem involved would be stupendous! This I believe to be the present-day prevailing public sentiment in this country. There are many less municipal plants in operation today than was formerly the case. In 1933, however, approximately 70 per cent of the population in communities voting upon the question voted in favor of it. This percentage has been lessened year by year until in 1937 when the percentage was approximately 88 per cent against public ownership. This is not surprising in view of the fact that the service rendered by these companies is almost uniformly excellent; that rates have been continually decreased even during periods of depression and attack; and that the domestic bill for residential service of the country is only about $2.94 per month, or less than 10c a day. At the present time 95 per cent of the electric output of the country is from the plants of private companies. To those who are interested in the further detail of this feature of the subject, I commend to their attention an article published in the April number of the *Savings Bank Journal* entitled, "Government Control; Fact vs. Theory," by Mr. C. W. Kellogg, Chairman of the Board of Engineers, Public Service Company, and the present President of the Edison Electric Institute.

The remaining irritant, to which time will only permit me to make passing reference, is that of taxation. This is common to all industries of every kind but has been particularly baneful in the matter of the electric utilities, upon which in addition to all other taxes, special discriminatory taxes have been levied. In 1937 the utilities paid 76 per cent more taxes than they paid in 1929. Approximately $1.00 in every $6.00 of gross revenue now goes for taxes. 50c per month of the revenue above referred to from domestic customers of electric companies must go for taxes. And these taxes are discriminatory, because customers of publicly owned systems are allowed to escape this tax burden.

Now we are all good Americans, and our primary object should be and is a desire to cooperate in relieving the country from its serious financial and economic burdens through sound economic policies to the end that all may find employment at a fair wage, under proper working conditions. To this end we should all cooperate in every manner possible. And so too, I think, the Government should cooperate. And I have it in my mind that no one concrete thing that the Government could do would be more productive of beneficial results—much more far reaching than its effect upon this industry itself would be an announcement that it would rest content with what has been accomplished to date in reforming abuses by utilities where they previously existed and that no more baiting of this industry was in contemplation. If I am right that this would stimulate all business, the existing spare capacity of the electric companies would be exhausted quickly and they would be in the market for large additional capacity. This in turn would

(*Continued on page* 214)

The Fourth General Engineering Meeting

By Alexander Maxwell
Director of Engineering, E.E.I.

THE fourth general meeting of the five engineering committees of the Edison Electric Institute was held at Edgewater Beach Hotel, Chicago, May 2 to 4, inclusive. The event was successful, measured by attendance and by the amount and quality of work done. It was also indicative of the natural growth of a custom that appears to supply a real need in the industry for a medium for the exchange of operating or engineering ideas and experiences on a broader scale than that provided by separate meetings of the more highly specialized individual committees.

Sessions of one committee or another were going on morning, afternoon and evening from Sunday evening to Wednesday afternoon, all on planned programs which represented a good degree of concentration of effort. The total attendance for the series of meetings was about 250. The actual membership of the five committees, Accident Prevention, Electrical Equipment, Hydraulic Power, Prime Movers and Transmission and Distribution, comprises 132 individuals and, on the basis of actual attendance about 100 persons were available to conduct the regular business of the committees with adequate efficiency. The remainder of the attendance was entirely voluntary; in a definite way this additional attendance was a measure of the interest and timeliness of the subjects discussed in the meetings.

It is the custom of the engineering committees to have their meetings open to other utility engineers as well as committee members. In this way it is expected that utility engineers who are able to be present, in addition to the membership of the committees, may benefit by the papers and discussions. For the past two years this practice has been extended to provide for a general meeting of all of the committees at which subjects of general interest to all utility engineers may be presented. Due to the crowded calendars of the committees, these general sessions have been arranged as dinner meetings, thereby avoiding an extra day's attendance or a conflict with the scheduled committee sessions while providing what is practically the only opportunity for social intercourse.

MR. MAXWELL

This year the participants in the general meeting had the privilege of hearing an address by Mr. C. W. Kellogg, President of the Institute, who spoke on the duties and responsibilities of the engineers of the industry, and by Mr. L. F. Seybold, Assistant Vice-President of the Milwaukee Electric Railway and Light Company, who described the significance and the features of a state wide survey of electric power facilities in Wisconsin. The addresses of Mr. Kellogg and Mr. Seybold are reproduced elsewhere in this number of the BULLETIN.

Sometimes there appears to be a tendency to associate engineering activity with construction and new development alone. The fact that the problems of operation and technical management demand at least an equal amount of engineering attention is amply shown in the work of the several committees at this meeting and at many others. Indeed, taking into account the number and variety of the operating problems that are dealt with in these committee meetings, problems which lead to the refinements of efficiency and service reliability so vital to the industry, the conclusion is warranted that the problems of operation are the real justification for technical committee activities, certainly as much, if not more than, the problems of engineering construction.

Sampling at random among the many subjects presented for discussion at the various sessions the following may be referred to particularly as illustrative of the extent to which committee activities are directed toward the strictly practical objective of improving operation and thereby improving service to consumers.

An excellent series of brief papers was presented dealing with the general subject of lightning protection, especially with respect to the use of the counterpoise and other features of grounding. The object of this symposium and discussion, which is but one chapter in a long series of discussions of experience and analysis of research data, is of course the improvement of the service reliability of lines. While it is not yet possible to rate many lines as "lightning-proof" there is no doubt that most important lines have made much progress toward this ideal, and that the general level of serviceability has been raised steadily. It has been done by studies and discussions similar to this one described.

The extent to which the problems of steam power production are influenced by the properties of metals at high temperatures is revealed by the amount of attention devoted to this subject. Modern power production technique has also rendered the correct treatment of feedwater a matter of first rate importance, to avoid deleterious effects upon the metals exposed to contact. Both of these are matters of much importance in the day-to-day operation of steam plants, and in addition to their possible effects on service reliability, they have important bearings upon maintenance expense and repairs. Thus it has come about that a very considerable part of the activities of steam power production engineers is currently devoted to problems involving metallurgy and chemistry.

At a joint session of the Electrical Equipment and Transmission and Distribution Committees problems relating to the service of consumers' equipment were presented upon a broader and better coordinated basis than heretofore. These are the problems of "utilization." Each of these committees has devoted an increasing amount of attention to such subjects in recent years. These

studies have now reached a stage where it is desirable to correlate them, with the object of avoiding duplication and also to insure that all applicable factors shall be considered.

The problems in the utilization field are not altogether new, they have merely become more pressing due to the natural growth of consumers' loads and progressive refinements in the margins of capacity and regulation on the supply side. On the consumer's side there have appeared in common use many new types of equipment which are large enough to react importantly upon the supply system and which are considerably more complex in operation than typical older forms such as incandescent lamps and relatively simple motors delivering raw mechanical power. On the supply side there are systematic changes in demand and diversity to be considered as well as new problems of regulation and costs of distribution.

The keynote of this "utilization" part of power supply engineering is the appreciation of the necessarily close connection between the system of supply and the consumer's installation, in short, that the company's distribution system and the consumer's equipment, consisting of conductors, controls and utilization appliances, are physically but one system. In order to maintain a suitably high level of service it is quite likely that many of the things to be accomplished to make these work together at best efficiency will require to be done in connection with the consumer's equipment. This is definitely in the consumer's interest and is a normal part of the task of rendering service. Thus this work undertaken jointly by the two committees dealing with the electrical system is quite closely related, although entirely technical, with the activities of the Sales Committee, and in fact is a necessary supplement thereto.

At the Dinner Meeting—President Kellogg, Toastmaster Eales and Speaker Seybold

This and other informal photographs of the Engineering Meeting in this issue were made by Mr. R. N. Conwell

It may be interesting to notice that the activities of the Engineering committees are organized upon a continuous basis. While, in a measure, the Spring meeting is a culmination of the work for the period since the previous September, it does not by any means represent a discontinuity or disruption of work in progress. The work that the committees do and the problems that they deal with are dictated by the technical conditions existing in the industry. Some problems may be, and are, disposed of in short order. Many others require patient and sometimes laborious researches and careful discussion before a satisfactory solution is found. For these reasons the committees have found it desirable to be organized for continuous effectiveness, and they are in fact subject to call at any time to supply their expert judgment and experience in the fields for which they are specialized. The individual members may change but the work goes on.

It has been observed that this type of organization makes for economy as well as efficiency. Ordinarily, when a committee is set up in an organization somewhat more than half of the time and effort goes toward the mere task of organizing, getting together and appraising the assigned problem. What available time may remain is devoted to discussion and solution of the problem. These sources of inefficiency, which are important when it is considered that the members of committees invariably have other things to do, is avoided in the case of such standing committees as the technical committees of the Institute. When they have nothing to do, they do nothing and no expense or time is spent; when they are wanted, which appears to be pretty often, they are there, fit and ready within their assigned scopes.

Everyone Enjoyed the Joint Dinner Meeting

Many Frontiers Remain for the Utility Engineer

By C. W. Kellogg
President, Edison Electric Institute

An address at the dinner meeting of the E. E. I. Engineering Committees, Chicago, May 3, 1938

I COUNT it among my most agreeable duties as President of the Edison Electric Institute to attend the national gatherings of its principal committees. It is agreeable because it is always a pleasure to express thanks and appreciation for good work well done. The Institute is essentially a cooperative enterprise, wherein the ideas and experience and enthusiasms of each are pooled for the benefit of all. In this work the Institute is but carrying on a tradition and a practice that go back to the earliest days of the electric utility business. Our industry has always been dedicated to the public service, no one company hoping or expecting to get ahead by exclusive patent rights or special methods not willingly shared with all others engaged in furnishing that service.

The development of the electric utility industry to its present huge proportions, whether as to capital invested or kilowatts installed or number of customers served, has required the solution of problems of finance, sales and human relations, both within and without, of all of which no one could be more conscious than myself. These problems are indeed fundamental to our success, but it should never be forgotten that the industry from its inception has been and continues to be basically an engineering enterprise. Engineering furnishes the raw material we have to sell. Engineering determines the quality of that raw material, how far and how successfully we can distribute it and the price at which we can sell it. It can be readily seen, therefore, that until the engineer has performed his function in respect to electric service, the other great problems are merely academic. Might we not go further and say that if all our past problems had been as successfully met as the engineering ones, we should have had a much less troubled history than we have had.

Comparisons are odious, but, if indulged in, should be made entirely fair. The extra-engineering problems of our industry derive their poignancy principally from their large percentage content of human nature—frequently a much more difficult thing to handle than the laws of inanimate nature with which the engineer deals—laws which when once discovered never change due to hope, fear, pique, indigestion, selfishness or any of the other well known forces of human nature.

I have said this much by way of refutation of a frame of mind which was frequently expressed in the industry as long as a quarter of a century ago, namely, that the engineering problems were all solved and that for the future the electric industry would settle down into a more or less humdrum commercial enterprise. In the short time at my disposal it might be interesting to consider what the main lines of development of the industry have been during the last 25 years and to see what part engineering has played in the process. Let us therefore compare 1912 with 1937.

In that period the population of the United States increased about 40 per cent and the cost of living increased about 50 per cent. Electric customers gained in number from 3.8 to 27 million; kilowatt-hours sold grew even faster—from 11 to about 100 billion. The average residence rate was cut from 9c to 4⅜c and the average residence energy consumption was increased from 260 to 800 kilowatt-hours. These are striking results and are a monument to the commercial effort that produced them. Let us see, however, how much they depended upon engineering achievement during the quarter century under review.

The great diffusion of electricity would have been quite impracticable without the development of high tension transmission, a distinctly engineering job. The further great extension both in number of customers and in energy consumption per customer (the latter made possible by rate reductions and the development of new uses for electricity) were all based on two great and fundamental engineering accomplishments, the reduction from 4.4 to about 1.4 in the pounds of coal required to produce a kilowatt-hour (the latter figure at its best is now down to .8 or .9 of a pound) and the intensive work of the manufacturers in the design and improvement of electricity-consuming devices. While, therefore, the development of electricity would have been substantial in any event during the past 25 years, it could not possibly have been as great as it has been but for what the engineers have done. Yes, ours is still basically an engineering business.

I have an idea that the reason for a tendency of the commercial men to belittle engineering is that, after a definite step forward has been made, progress from that point on appears to be confined to refinements. What the commercial man probably fails to realize, however, is that an engineering refinement, once developed, is made for good (it does not have to be resold or redemonstrated again and again) and that the sum of such refinements over the years makes a formidable aggregate of accomplishment. While we may have passed the pioneer stage in our industry, there still remain many frontiers to be explored and pushed further back. These are at once an inspiration and a challenge to you engineers. I shall attempt to mention but a few of these fields for further development because you know better than I do where they lie.

The serious interruptions which have occurred in very recent years in some of our largest electric systems which were supposedly immune from such large scale outages surely indicate that there is a broad field here for the exercise of the highest engineering skill and ingenuity. Also as long as the best generating stations lose more than two-thirds of the heat energy of the fuel they consume and the average stations lose about three-quarters, the better utilization of heat will remain a powerful incentive to your further ingenuity and effort.

Insulating materials are still subject to important limitations. They afford a broad field for engineering as well as scientific research and development.

Lightning protection has not reached a sufficiently reliable state, at least for lower voltage lines, and much remains to be done in the field of control, of switch gear and relaying, notwithstanding the fact that the past ten years have witnessed most remarkable progress in these fields.

I was very much impressed two years ago by Mr. Silver's paper reviewing

progress in lower cost rural line construction, and I feel that no small amount of credit for the remarkable increase in the number of electrified farms in recent years can be assigned to the engineering advance in the building and operating of rural lines, but I am sure that this group before me would be among the last to admit that the final word has been said in rural distribution engineering.

At long range, present-day achievements with electronic devices suggest various possibilities in modulation of circuits that may have important effects upon the transmission, utilization and control of electric energy beyond anything definitely in view now.

It would seem that perhaps the outstanding field to which first rate engineering talent should now be directed is that of utilization. The importance of consumers' installations may be illustrated by the fact that the sale of electrical appliances alone, exclusive of radio sets, wiring installations, etc., amounted in 1937 to approximately $900,000,000, or about double the total construction expenditures of our industry of $455,000,000. These consumer installations have grown more or less independently of the utility systems which supply them and they now show various technical features which might benefit by better coordination with these systems. For example, it is not too much to say that the design and cost of distribution systems is determined to a very considerable extent by the loads which they supply rather than by the conditions of delivering energy in usable forms at particular points. Thus the necessity for meeting the regulation requirements of illuminants and heating appliances, for supplying loads at excessively low power factors or with undesirable wave forms, or with excessive starting currents, impose costs upon the distribution system that might otherwise be avoided. It is quite possible that a more perfect coordination of power supply clear through to the utilization devices themselves would achieve for the consumers better service at less total cost to them. As the consumers make larger applications of electric energy, it is safe to say that the importance of this coordination between load and supply will become proportionately greater and will demand engineering ability more on a par with the engineering that has been applied to the functions of generation, transmission and distribution.

An excellent example of the benefits already derived and yet to be derived by devoting engineering effort to utilization facilities, is in the progress that has been made and that I think we shall shortly see in the field of interior wiring. This has long been recognized as the neck of the bottle but by investigation and experiment, developments have been encouraged and actual progress has been made that points the way toward removing this handicap or substantially reducing its hindering effect.

I have just one more observation I should like to make. Engineers are notoriously given to fraternizing with their own kind. This is perfectly understandable (arising out of the belief that non-technical people will not understand you), but if your attention is to be given more to the engineering problems of utilizing electric energy, this will carry with it a greater necessity to work successfully along with others than engineers. Obviously, it places more of a premium on ability to sell your ideas to persons often without technical training. This is not a new development but rather an extension of what you have already experienced. It is a natural development which must be met in due course and I am confident that you as a group will be able to appreciate the requirement and take it in your stride.

While, therefore, I am here to thank you in the name of our industry for your useful and cooperative efforts in its behalf, I wish also to congratulate you. Our industry is based on engineering, but it is based also on service; and one of the oldest principles mankind has discovered is that in this world we get what we give. The true reward for all your good work is therefore not in the thanks that I or anyone else can give but in the satisfaction received from honest and effective work given to the great common enterprise in which we are all engaged.

Three chairmen preside at joint meeting of Accident Prevention, Electrical Equipment, and Transmission and Distribution Committees

A subcommittee meeting at lunch

UTILIZATION VOLTAGE

A Symposium, under the Sponsorship of J. H. Foote and H. P. Seelye, presented at the Joint Session of the Accident Prevention Committee, Electrical Equipment Committee and Transmission and Distribution Committee, Chicago, Illinois, May 3, 1938.

The Problem of Utilization Voltage Standards

By Howard P. Seelye
The Detroit Edison Company

THE problem of proper standards for customers' service voltage, or utilization voltage, is one of long standing in our industry. In fact, it goes back to the beginning of it. It might seem that with such a long history and with the plentiful discussion which it has had that no problem would now remain; that satisfactory universal standards would have long since been established and further consideration would be unnecessary. To a degree this is true. Approximate standards have been agreed upon. There is no longer any question in this country between 115 volts or 230 volts for lamps, for example, and motor voltages are 110, 220, or 440 rather than some other odd voltages. On each of our own systems, workable standards have been set up so that some of us probably do not realize that there still is a problem worth talking about.

On the other hand, a look at the broader aspects of the situation shows that some further discussion and study is decidedly needed. While present practices fall within certain limited ranges of values, these ranges are still broader than is desirable and than is probably really necessary. It is too much to expect that one uniform set of standards can be adopted by everyone, at least for a long time to come, although this would no doubt be an ideal condition in many respects. It would seem, however, that a thorough understanding of the nature of the problem and the possible advantages of greater uniformity, might well lead to a steady, even though gradual, improvement. That is the purpose of the presentation of the subject which is to be given here today.

Specifically, the problem of utilization voltage standards consists of two parts:

1. What value should be designated as the nominal voltage?
2. What range of voltage above and below the nominal should be allowed?

It is natural that the answer to these two questions should be somewhat different on different systems. Past practice usually dictates present policies to a large extent, and the nominal service voltage on different systems has varied all the way from 110 to 125, with probably some very good reasons to justify the choice in each case. No matter what the nominal voltage may be, on any operating system only a part of the customers get that voltage. Since there is always some voltage drop in transmitting power over wires and through apparatus, it follows that some customers must get service voltage higher than the average and some lower. On well consolidated systems, the range may be small. On wide spread systems it must necessarily be relatively large. D.C. systems customarily had a nominal of 120 volts—A.C. systems were usually lower than that until the Y-connected, four-wire network brought in the 120/208 volt combination.

The manufacturers of apparatus must design with some specific voltage in mind, but also must allow for satisfactory operation over some range of voltage variation. With a wide variety of practice in both nominal voltage and in range of variation how can he choose the best compromise? When several different varieties are necessary to cover the field, how many are required and where should their ratings be established? This is the nature of the problem we present. A considerable amount of confusion exists. Can we do anything to simplify and coagulate it?

The discussion of this subject has been divided into several parts. In the first one the characteristics of various types of utilization equipment will be considered. Recognizing that such equipment cannot be operated at its best particular voltage in all of its applications, the variations in operating characteristics as the voltage is raised or lowered becomes important. Different types of equipment, such as lamps and motors, will probably have different ranges in which the operation might be considered satisfactory yet all must operate on the same system. A comparative study should be valuable in pointing to the best range for general use and what point in that range can best be used as the design or nominal rating for each type of equipment.

The second part of the discussion will deal with the characteristics of distribution systems as they affect the choice of service voltage. The nature of these systems is such that some range of service voltages is inherently necessary. A study of the natural voltage regulation of distribution facilities and of the limitations of various voltage-regulating equipment, together with the basic differences in standards on different systems, should help clarify the question of whether all the variations now prevalent are really necessary. Economic and local legal limitations also have an important bearing on this phase of the subject.

In a third part of this program some specific examples of problems encountered in connection with utilization voltage standards will be presented. In the fourth part a program for further joint study of this subject by the Electrical Equipment Committee and the Transmission and Distribution Committee will be suggested. The program given today has been intended to be more of an introduction than any attempt to give the answers to questions raised. It is believed that the importance of the problem will be demonstrated and that our Committees can well devote some time to a careful study of it.

The trend of sale of lamps of various voltages is shown in the article on Page 422 of the October 1936 issue of the E.E.I. Bulletin.

Effects of Voltage Variations on Motor Characteristics

By A. C. Monteith

Westinghouse Elec. & Mfg. Co.

THIS is a broad subject but possibly a general picture can be obtained by a study of the effect of varying voltage on five of the more important characteristics; namely—

1—Torque
2—Losses or Heating
3—Reactive KVA or Power Factor
4—Speed
5—Starting Current

In the majority of motors the first consideration of the designer is torque. Will the motor start, drive the machine and for this load will it stay on the line with reasonable voltage fluctuations? The pull out or maximum torque of an induction motor varies as the square of the voltage and in the majority of induction motors the starting torque follows this law. Thus we simply say that for increased voltage the torques are better and for decreased voltage they become less, and if the voltage is decreased too far, torques may become inadequate.

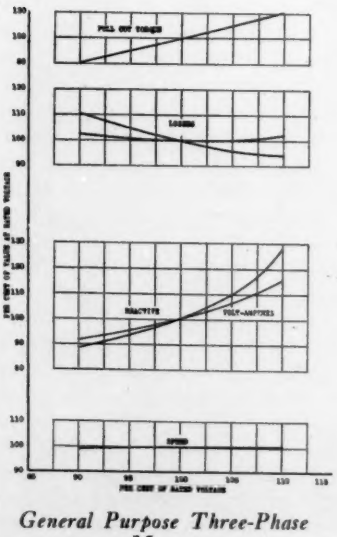
The next factor is losses or heating. The insulation in the vast majority of motors is fibrous in nature so that temperatures must be held within certain limits to obtain a reasonable motor life. The designer must therefore lay out the motor with proportions such that the heat can be dissipated and the temperature stay within recognized limits. With the demand for lower starting currents of general purpose motors there has been a trend to motor design such that the losses decrease with increased voltage. In this case high voltage is more desirable than low voltage. It might be desirable to explain this statement a little more in detail. The demand for lower starting currents can be met by special rotor design to give high effective resistances at starting or it can be accomplished by increasing the reactance of the motor by adding turns, which results in a motor with the copper loss higher than the iron loss. In a large number of cases examined the copper loss was about double the iron loss at full load. Assuming that with constant load the copper loss varies inversely with the square of the voltage, and the iron loss directly with the square of the voltage, increasing the voltage decreases the copper loss faster than the iron loss increases resulting in a lower overall loss. The method of increasing turns is resorted to in general as it is the more economical way of limiting starting current, within the limits of being able to meet the torque requirements. When torque requirements cannot be satisfied, then the more involved types of construction are used.

This discussion of losses or heating applies to the general purpose 3-phase motor of all sizes up to 200 hp and to a large extent to the general purpose or normal saturation single phase motor. For these motors, as stated, increasing the voltage decreases the loss and decreasing the voltage increases the loss.

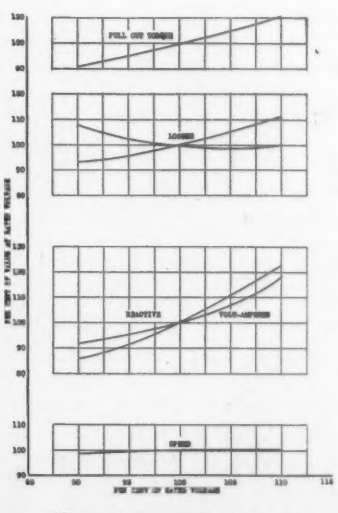
In the case of the small single-phase motor built for loads such as washing machines, ironing machines, etc., higher saturations are sometimes used in the iron. This results in a predominance of iron loss at full load so that an increase in voltage results in the iron loss increasing faster than the copper loss decreases. The net result is an increase in losses. This motor therefore is better adapted to low voltage as far as losses are concerned and, of course, provided the torques are sufficient.

The third item, Reactive KVA or Power Factor has the same variation with voltage in all motors of the induction type. The reactive KVA increases with increased voltage and decreases with decreased voltage. As would be expected, these changes are more pronounced in the motors with higher saturation. To the power companies it means that higher voltages than standard will result in poorer system power factors.

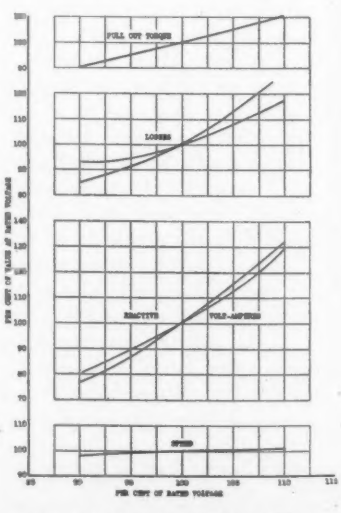
The fourth factor, "speed," is little affected by reasonable voltage variations. This factor is of minor importance except in a few special cases.



General Purpose Three-Phase Motors



Normal Saturation Single-Phase Motors



High Saturation Single-Phase Motors

The fifth factor, "Starting Current," follows a very definite law for induction motors starting as such. The starting current is limited by the reactance and so varies directly with applied voltage.

I have selected at random a few representative Westinghouse motors in the classes discussed, and a review of their characteristics will serve to illustrate the general points covered. The bands indicated are not necessarily complete for the class of motor discussed.

Considerations Involved in the Operation of Domestic Heating Devices Operated Above and Below Design Voltage

By William F. Ogden

Edison General Electric Appliance Company, Inc.

THE subject has to do with the effects of variation in applied voltage on the performance of domestic heating devices. This discussion is designed to be general in nature, to serve as an outline of the considerations germane to appliances in common use in American homes, and to stimulate discussion and further investigation of the subject.

The principal effects of voltage variation on heating devices have to do with the following:

1. Heat input, which in most applications is synonymous with speed of heating.
2. Temperature, which affects the life of the element, and also in some cases the effectiveness of the heating device.
3. Efficiency.

The heat input in a usual resistance type heating element varies closely as the square of the impressed voltage. Thus, a five per cent increase in voltage increases the wattage, and therefore the heat input, by about 10½ per cent. Likewise, a reduction in voltage to 90 per cent reduces the wattage to about 81 per cent of normal.

The temperature of a heating element varies somewhat proportionately as the first power of the impressed voltage. The exact relation depends not only on the particular design of heating element, but also on the shape, contact, and reflective value of the utensil or surface placed against the heating element. It readily can be appreciated that the temperature rise would be proportionately greater on an element over which is placed a brightly polished, highly efficient reflector, in the form of an aluminum cooking utensil, than that temperature rise which would be experienced in an open coil element (of lower watt density) in an oven freely exposed to circulating air. Most tests show, however, that the temperature rise varies numerically at not greater than the first power of the increase in voltage.

The change in efficiency, as far as heat transfer is concerned, is not large with the usual commercial variations in voltage, and usually tends to increase as the voltage is reduced. The practical efficacy of the cooking device may vary much more noticeably with varying voltage for certain cooking operations. Broiling is an example. This will be discussed more in detail below.

Domestic heating devices include such small socket type appliances as hand irons, toasters, roasters, waffle irons, percolators, etc., and also include major heating appliances such as water heaters, ironing machines, and ranges. Some of these appliances are automatically controlled; some are not. Some are designed for heat storage, and others are useful as heating devices only during short intervals of active heating. The effect of voltage supply above and below design voltage varies greatly with the type and use of the appliance. Some are quite sensitive to voltage changes, and others will probably give satisfactory service with rather wide variations in the value of supply voltage.

Experience shows that most small socket type heating devices, as well as storage type water heaters, usually give good customer satisfaction over a rather wide range in voltage. That very popular heating appliance, the flat iron, is marketed in wattages ranging from about 550 to about 1000. In the higher wattages it is usually thermostatically controlled, while in the lower wattages it is often turned on and off by the operator as conditions require. The 1000-watt iron operated at voltages 10 per cent below its rating still has a greater wattage input than an 800-watt iron of similar size operated at its voltage rating, which rating apparently has a wide appeal to many purchasers. At overvoltages, the thermostat restricts the heating time to keep the temperature within bounds. This illustrates the rather wide latitude in the case of such an appliance. Satisfaction is probably so general also because the operator becomes accustomed to the speed and capabilities of the particular iron being used.

Water heaters usually will give satisfaction over a very wide range of operating voltage. A longer heating time is required with voltage below normal, but time may usually be available, and if the voltage is excessive the thermostat will open the circuit that much sooner.

Customer satisfaction with the domestic electric range is probably affected by undue voltage regulation to a greater extent than for other domestic heating appliances. However, the effect of voltage variation is not of the same order when considering various parts of the range.

The electric range oven, except possibly for broiler operations and for one or two specific baking jobs, can almost be classed as a thermostatically operated heat storage device able to operate under rather wide voltage limits, particularly if the wattage provided in the oven be in excess of minimum requirements. Experience has shown that even with maximum wattage connected, the heater wire temperatures of oven units usually operate well within the limits known to provide satisfactory life with voltage variations ordinarily encountered on electricity supply systems. The problem, then, is one of providing enough wattage in the oven so that at the lowest voltage to be expected, the desired oven temperature will be maintained. At voltages above this point the thermostat will interrupt the circuit to keep the heat input within bounds.

The matter of the preheating speed or the time to reach thermostatic cut-off temperature is important in the selling of electric ranges. Modern electric ovens are very fast. For instance, a typical electric oven in a modern range operated at design voltage, will preheat to 400°F in about 8½ minutes. If the

voltage is 90 per cent of the design value this time is increased only about 1½ minutes, an increment hardly to be noticed in practice. Many older ovens on supply lines today require 20 minutes for such preheating.

For broiling operations, experience has shown that high heat input is necessary. For instance, at least 25 watts per square inch is required if a one-inch steak is to be really properly broiled. Most broilers in ranges built until fairly recently failed to provide any such heat density at design voltage, let alone at reduced voltage, so that broiling operations often were unsatisfactory without respect to low voltage conditions. By putting in an adequately high wattage broiler satisfaction is possible with voltages somewhat below design voltage, provided that at this lower value of voltage the input is still of the order of 20 to 25 watts per square inch of gross area under the broiler.

The baking of large oven meals from a cold start is becoming more and more a common practice. Most automatic timer oven operations are done on a cold start basis. If the meals include a fruit pie it is necessary that the application of heat be sufficiently rapid to insure the setting of the crust of the pie before it becomes soggy. If the wattage available is not adequate to increase the temperature at the proper rate, the cooking may be unsatisfactory. It is therefore necessary that adequate wattage be provided in the heating element of the oven so that at the lowest voltage to be expected the heating speed will be satisfactory. This, again, is a question of balancing the wattage design of the heating element against the voltage variation contemplated.

Probably 70 per cent of the energy consumed by an electric range is consumed by the surface units, and the surface unit is perhaps most sensitive in terms of cooking satisfaction and in life to voltage variation.

Service records show that many of the old open coil or cast-in units are still operating on electric ranges. Often they are slow. They probably were slow when new, and they are slower yet today because of oxidation of the wire, with resultant decrease in wattage input. They may have had what might be called a satisfactory life even though over-voltaged with impunity, because of the low wattage density at which they operated. In many cases less than 1000 watts were actually spread over an area seven inches or more in diameter, giving wattage densities in the order of 25 watts or less per square inch.

Several years ago this picture began to change. Increased speed was emphasized. Manufacturers made units smaller, and began to cram them with higher wattages. Enclosed units began to take the place of open units. They were faster and more efficient. Open coil units were also redesigned to keep pace with the demand for increased speed. These developments have raised the wattage density of surface units 50 per cent and more over the practice of former years. It is obvious that much less leeway in terms of overvoltage is allowable under such conditions, so that the maximum operating voltage of surface elements is now a most important consideration confronting the designers.

In the new standards for domestic electric ranges, which it is hoped will be adopted shortly, the maximum operating voltage is specified. It is expected that designers will use this figure in calculating their watt densities and temperature limitations, and that supply companies will not exceed this voltage in the interests of long element life. Having an upper limit agreed upon, it is now possible for the designer to eliminate some undetermined leeway of design which might be called a factor of uncertainty. This should make for greater satisfaction and greater uniformity of performance, since all range designers and all electricity supply companies will have before them the agreed upon limitations of design and of use. Assuming that this upper limit encourages the designer to put all the wattage possible into the surface element, it is readily seen that a greater density is available at reduced values of voltage than if he were forced to embody in the design greater leeway due to uncertainty. Thus, complaints caused by slow operation due to low voltage should be reduced, and the versatility of the element should be increased.

With its very high speed, it has become evident that the modern surface unit may give unsatisfactory performance due to too "fast" cooking even on the low heat. It has therefore become evident that extra low or simmering heats are desirable, and a number of ranges are now available which provide, in one way or another, very low or simmering values of heats for surface units. Voltage variation is of minor importance in connection with these reduced heats, except possibly for "double boiler" cooking operations done in a sauce pan—a practice which is becoming more general.

As a matter of fact, even on the high heat, low voltage only retards the speed of heating up. Once water has reached the boiling point food will cook just so fast and no faster. Low voltage is therefore of most significance in this one respect, as far as surface units are concerned, whereas overvoltage has much to do with the life of the equipment when operated not only on high heat but also to some extent on reduced heats when such connections employ portions of the heating element at full voltage without automatic temperature control.

The matter of the life of a surface element has been the subject of much study and investigation. The life is intimately associated with operating temperature and that is a function of watt density, which again is a function of operating voltage. Involved are also such variables as the detailed design of the unit itself, the materials of which it is made, and processes used in its manufacture. Exhaustive tests have shown that the life characteristic of an element is not a function which as yet can with certainty be expressed as a simple proportion in terms of increasing voltage. Beyond a certain limit the life expectancy decreases very rapidly in many instances, so that every element manufacturer must decide as to the maximum density which he can use with satisfaction at the maximum operating voltage. It is obvious that those heating elements which in design and construction allow greater wattage densities at the maximum operating voltage not only give greater speed and customer satisfaction at normal voltage, but will also give satisfactory cooking performance at reduced voltages below which other element designs might fail to produce a satisfactory heat output. Thus it is evident that considerations of life, speed of cooking, cooking efficacy where high temperatures are involved, and adaptability to a wide range of operating voltages, all are involved in the particular designs and constructions employed by the various manufacturers. Some designs are more versatile than others.

To sum up, heating devices will give satisfactory service when operated at their design voltage if the design is such as to give an adequate heat output (wattage input) to keep the heating-up time within reasonable limits in bringing food to cooking temperature. The wattage input must also be sufficient to

produce an element temperature which will properly broil where this operation is required.

The minimum satisfactory operating voltage is determined as that point at which the heat input becomes insufficient satisfactorily to maintain these cooking operations. Since the heat input varies as the square of the applied voltage and the temperature approximately as the first power of the applied voltage, it is obvious that the greater the output incorporated in the element at the design voltage, the lower the impressed voltage may become before this limit of satisfactory operation is reached.

Since considerations of life are paramount, the element design is really set by the maximum operating voltage beyond which life expectancy may be seriously reduced. Element designs which have greater leeway in this respect can be crowded with greater heat input and will therefore have greater versatility in matters relating to normal operation, and especially as regards adaptability to operation under low voltage conditions.

Notes on Effect of Varying Voltage on Incandescent Lamps

By A. K. MacNaughton

The Commonwealth and Southern Corporation

IN considering the elements of lamp design which fit in to the picture of voltage standardization, it is of interest to review some of the principal lamp characteristics which are affected by the application of voltage above or below that for which the lamp is designed and rated. The principal incandescent lamp characteristics affected by a variation in voltage are as follows:

1. Watts input
2. Light output
3. Life
4. Annual cost.

These characteristics have been made familiar to all of us who have studied the ingenious slide rule which conveniently shows the interplay of these various factors. Data taken from this device gives the following information:

	Relative Performance		
Impressed Voltage..	95%	100%	105%
Watts Input.....	93	100	108
Light Output.....	85	100	118
Relative Efficiency..	91	100	109
Life	175	100	55

This tabulation shows that life is most drastically affected by variation in voltage, and that light output is the characteristic next most drastically affected.

The annual cost of the lamp as a device to illuminate must be based on the replacement cost plus the cost of the current used as related to the illumination received or desired. If current is relatively expensive and lamps are relatively cheap it may be economical to improve the efficiency of the device, say 10 per cent, and to increase simultaneously the replacement cost by about 100 per cent. On the other hand, if the incremental cost of electricity is cheap and the efficiency of the illumination is not of major consequence, the replacement cost becomes paramount. These, it would seem are the important considerations from the customers' standpoint. Whether or not the application results in merchandising more or fewer lamps or selling more or fewer kilowatthours should not primarily concern the customer aside from the considerations outlined above.

Mention was made of incremental cost. This is really the cost which must be considered in a question of this sort; not the average cost of all the current used. Whether a modification of this or that lamp characteristic will be profitable is a matter of balancing the costs which will exist after a certain procedure is adopted against those which would exist if it were not adopted. In other words, if more illumination is to be obtained by increasing lamp voltage rather than by increasing the rated wattage of lamps in a given situation, the cost of the increment in current consumption and the increased cost of the lamps themselves constitute the variables to be studied in relation to the increased illumination afforded. Some studies which utilize average costs have ignored this point and, it is felt, have sometimes reached incorrect conclusions.

In commercial lighting installations or in applications of the larger sizes of domestic lamps such as are used in kitchen ceiling luminaires or IES lamps, the efficiency of the lamp is of some importance and the cost of the lamp may be relatively small in proportion to the cost of the current which the lamp may use. For such applications greater illuminating efficiency and shorter lamp life may be of interest.

On the other hand, there are many applications of the smaller sized lamps, and particularly those lamps which are of special shapes or tints where the decorative factor is paramount. Such lamps are sometimes heavily shaded and impart color and decorative treatment rather than intense illumination. In those applications replacement costs may be more important than considerations of lamp efficiency, and long life may be of importance. Operating such lamps at lower voltage intensities may be economical, may promote customer satisfaction, and may keep load on the lines which would be lost due to tardiness in replacing short-lived lamp equipment.

In studying the place of lamp ratings and characteristics in the general picture involving motors, heating devices, miscellaneous equipment and lamps as applied to an integrated distribution system, it is of importance to note that lamps have by far the shortest life of any equipment in the picture. Their rated characteristics as related to operating voltage variations should therefore be subordinated to the requirements of the more permanent and longer lived utilization equipment, since not only can lamp characteristics and ratings be modified without too much difficulty, but in the process of time obsolete or incorrectly rated lamps would disappear and customers throughout the country would shortly be utilizing the new lamp equipment.

Mr. J. H. Foote reported at the Engineering Committee's joint meeting that final approval had been made of the E.E.I.-NEMA report on Electric Range Engineering Details Affecting the Service Requirements of Electricity Supply Companies. This report will be published shortly.

Voltage Regulation Limitations Imposed by the Nature of the Distribution System

By Harold Cole
The Detroit Edison Co.

WHENEVER an alternating current flows in an electric circuit, there is a loss of voltage due to the resistance and inductive reactance of the circuit. This loss of voltage is proportional to the amount of current flowing. With a definite current at a definite power factor, the loss of voltage may be reduced by either increasing the size of conductors, thereby reducing the resistance, or by reducing the spacing of conductors, thereby reducing the inductive reactance, or both. Increasing the size of conductor results in increased cost and becomes less and less effective as size is increased since the reactance remains practically constant. Decreasing the spacing of conductors sufficiently to greatly reduce the inductive reactance can only be done by the use of insulated cables, which also results in greatly increased costs where not necessitated by other considerations. The most effective way to reduce voltage loss is to increase the voltage of the circuit. For a given load, this will not only reduce the voltage loss in inverse proportion due to the decrease of current, but the voltage loss expressed in per cent will be reduced inversely as the square of the increase in voltage. Here again, however, there are increased costs to be considered, not only in the circuit itself, but in the associated equipment. It is also obvious that, other factors being constant, the voltage loss in a circuit will vary directly with its length. For any definite problem of transmission, therefore, there is a most economical combination of these factors, and, if any considerable amount of load is being transmitted for any considerable distance, an appreciable voltage drop must be permitted in order to stay within economical limits.

In a typical integrated power system, large generating stations will be located at points where fuel costs are lowest and where large amounts of cooling water are available. A system of transmission and distribution lines is then used to carry the power from the generating stations to all parts of the area to be served. In this way the cost of power generation is kept as low as possible but at the expense of some increase in transmission investment and losses.

Power losses and voltage drops will occur in the following elements of the system between the generating station and the ultimate current consuming devices:

1. The transmission lines
2. The substation transformers
3. The primary distribution circuits
4. The distribution transformers
5. The secondary mains
6. The service drops
7. The customer's wiring.

The proportion of voltage drop to be permitted in each of these elements should be determined by consideration of economy, the overall cost of the entire system being kept as low as possible.

The total voltage drop in all of the elements of the system will usually be large enough so that it will be necessary to install voltage regulating devices at certain points in the system to compensate for a portion of the drop in order to keep the voltage variations at the customer's service within reasonably close limits. The most effective point at which to install such voltage regulating devices is usually at the distribution substation. These devices may take the form of induction regulators, step voltage regulators, or tap-changing transformers, the ratio of which may be varied under load. Their function is to compensate for the voltage drop in the transmission system up to that point and usually to over-compensate so as to take care of some of the drop in the distribution circuits beyond that point. In many cases, where substations serve large areas, individual "feeder regulators" on each distribution circuit will be necessary to give uniform primary voltage on circuits of different lengths. This may be accomplished by the use of "compensators" which can be set to hold constant voltage at the "feeding-point" (first customer) at all times, regardless of the load on the circuit. Compensators can also be set so as to give a higher voltage at the feeding-point at times of peak load than at time of light load. If this is done, voltage drop in the distribution transformers and secondary mains may be partly compensated for and the total range of variation at the customer's service reduced.

The voltage drop in the distribution circuits beyond the feeding-point or first customer is obviously the most difficult to do anything about without a very great increase in investment costs. In urban systems, the distribution transformers, secondary mains and associated equipment constitute a major item in the total cost of the distribution system. Considerable study has been given to the economical design of this portion of the system. These studies show that for the usual load densities encountered, the usual daily and yearly load factors and the temperature conditions prevailing in most sections of this country, it is economical to load distribution transformers to well above rated load at the time of peak load. This, of course, results in an appreciable voltage drop in the transformer, usually of the order of three per cent. It also has been found that maximum economy in the spacing of transformers on the secondary mains produces voltage drops of the order of three per cent. Service drops are usually short but occasionally the voltage drops in them will be as high as one per cent.

If these were all additive, the voltage drop from the primary side of the transformer to the meter of the customer farthest from the transformer would be about seven per cent. Of course, all of the customers on this secondary main would be subject to the three per cent transformer drop, so the maximum variation between the farthest customer and the customer nearest to the transformer would be between three and four per cent, depending on the drop in their respective services. Now, if a customer in the next block is connected directly to a transformer which happens to be lightly loaded at the time, the variation in the voltage between this customer and the customer farthest from the heavily loaded transformer may be as much as five or six per cent. It is evident, also, that it will require very little additional load on a system designed to serve an area of low load density to cause voltage drops in excess of three per cent in sec-

ondary mains. It will require eternal vigilance to determine when such excessive voltage drops have developed, or preferably to anticipate their development by making necessary changes in advance.

With a five or six per cent possible difference in voltage supplied to customers connected to transformers nearest to the substation, it is evident that very little additional voltage drop can be permitted in the primary mains beyond that point. A drop of one or two per cent will increase this difference to about the limit of variation permitted by usual legal requirements. It will, therefore, be necessary to restrict the transformer and secondary drops to lower limits if considerable primary drop is necessary for the overall economy of the entire system. The use of higher primary voltages or the close spacing of distribution substations is obviously helpful in limiting the voltage variations in the primary systems, without giving excessively high voltages to some customers near the feeding point.

This discussion is strictly applicable only to overhead urban distribution systems, such as are found in the residential sections of most American cities. In the well built up sections of cities, it is possible to provide reasonably close regulation of voltage to customers (say, three per cent above to five per cent below nominal voltage) without excessively high system investments. In thinly settled areas, and especially in rural areas, the problem is more serious. Primary lines must necessarily be long because economic considerations rule against spacing substations very closely together. If high distribution voltages are used, the increased cost of distribution transformers, lightning arresters and cutouts will increase very appreciably and an economic limit is soon reached. Most companies find it necessary, therefore, to set a different standard of voltage regulation in rural areas, and most regulating authorities recognize the reasonableness of this difference in their requirements.

Recent developments in regulating devices for installation on lines in rural and suburban areas have provided a very useful means of overcoming some of the difficulties of maintaining satisfactory voltage conditions on lines in thinly scattered areas. Pole mounted step-voltage regulators or boosters are now available which will function as the load increases to boost the voltage at that point and assist in limiting the range of voltage variation to customers beyond. The use of capacitors to improve the power factor of the load and reduce the resultant voltage drop has also proved effective and economical in some situations, particularly in suburban, or even in urban areas as a temporary measure to postpone the construction of additional substations.

In contrast to the difficulties mentioned in rural areas, the problem of voltage regulation in densely populated areas where all wires are underground and where generating stations or substations are closely spaced, is much less complicated. Transmission voltage drops in such situations are small, and where secondary network systems can be used, supplied directly from the generating stations, the drop in these high voltage feeders and the network transformers may be compensated for by the regulation of the voltage at the generating stations. The limiting of the voltage drops in the underground secondary mains then becomes the principal factor in limiting the variation of voltage to the customers, and maximum voltage variations much less than has been shown necessary in overhead systems are feasible.

Thus far we have confined our discussion to the variations in voltage above and below a normal, or so-called "nominal" service voltage. Another, and perhaps more serious difficulty from the viewpoint of the manufacturer of electrical equipment, is the range of nominal voltages in use in this country. This range is roughly from a low of 110 volts to a high of 120 volts with a few systems using voltages below and above these values.

The low voltage a-c network, in order to have maximum economy, has to be able to serve three-phase power loads and single-phase lighting and appliance loads from one system of mains. The most satisfactory way to accomplish this is to use a three-phase, four-wire secondary system derived from a three-phase transformer bank, using a star or wye connection on the secondary side. The resulting secondary system with three-phase wires and neutral is ideal for the purpose except for one difficulty.

The ratio between the three-phase voltage between phase wires, and the single-phase voltage between each phase wire and neutral is 1.73:1 instead of 2:1. If the standard motor voltage of 220 volts is to be maintained on the three phase, it would require that the single-phase voltage be raised to 127 volts. If 115 volts is to remain the lamp voltage, the resulting three-phase voltage would be 199. The usual solution to this problem is to adopt a nominal 120 volts as standard for the single-phase service which made the three-phase voltage 208. This is practically close enough to the standard motor voltage to give satisfactory operation under most conditions. The single-phase voltage of 120 is slightly more severe on heating appliances, but, in some cities, has the advantage of corresponding exactly with the direct-current voltage used in the same area.

In raising the service voltage of a-c systems in areas not served by low voltage networks, however, the use of the star connection is not usually desirable, and the adoption of 120 volts for lighting voltage will result in a 240 volt service voltage for motors which is a little high.

There are a great many more angles to the problem of standardizing service voltages which are too involved to be adequately discussed here, many of which are tied up with the conditions existing on each particular system. There is often considerable expense involved due to the necessity of replacing substation transformers with new ones of a proper ratio, or reinforcing transmission of primary distribution systems to reduce voltage drops, or both; to say nothing of the increase of iron losses in distribution transformers designed for a lower operating voltage. If there is not sufficient resulting saving in the operating costs to justify the new investment required, it will be very difficult to persuade managements to spend money just to conform to someone else's standard.

Perhaps, as time goes on, inducements will be greater and natural replacements of equipment will occur which will make the raising of the lower voltage standards to the higher levels less costly. It may result in a general acceptance of a higher level, such as 120 volts, as a standard nominal voltage. If, in the meanwhile, more companies raise their nominal voltages to still higher levels, the difficulties of getting together will be prolonged considerably. I think it will be necessary to retain a number of standard voltage ratings for lamps, heating appliances and other equipment sensitive to voltage changes for some time to come.

Specific Problems in Connection with Utilization Voltages

By H. A. Enos

American Gas and Electric Service Corporation

THE problem involved in the correlation of utilization voltage levels and equipment ratings has various and often conflicting factors. These factors have come about primarily by the uneven rate at which system voltage levels and voltage ratings of equipment have changed since the industry began. There have been sporadic attempts at standardization of voltage ratings and levels, but these attempts have always been upset by the desire of different groups to accomplish certain seemingly desirable ends by departing from the trend toward standardization.

It might be well to discuss the effect of overvoltage or undervoltage on several different types of equipment. As far as lamps are concerned, customers will complain about excessive burnouts if the voltage supplied is generally higher than the lamp rating and if the lamps are undervoltaged there will be complaints of insufficient illumination. A reasonable variation from rated voltage does not affect the life of heating appliances to any appreciable extent, merely resulting in either slow or fast speed of operation. Overvoltage or undervoltage makes very little difference with small motors, as they are liberally designed and a reasonable amount of variation from rated voltage will not result in complaints, except in the case of certain applications where correct speed or power output is essential. The majority of the larger size of motors are either rated 220 or 2200 volts. This is a fortunate situation if the system voltage level is low, but if voltage level is high certain difficulties are encountered.

Radio sets, however, are generally quite susceptible to variations in voltage either above or below the design rating. Most of the older sets have marked ratings of 110 to 120 volts, with no taps on the power transformer, but they will not perform properly if the voltage varies much from 115 volts. Some considerable difficulty is encountered with radio sets, even if they have tapped power transformers to give a maximum of 120 volts if the voltage goes much above 120.

It is generally conceded that an increase in the system voltage level above 115 volts is desirable from several standpoints and most utilities are endeavoring to raise the level. The following are a few of the conditions which have been met with in attempting to raise the level of voltage. One important factor in the utilization voltage level is the voltage level of transmission systems. These voltage levels are usually established on the basis of load division, load interchange or power factor control. It is therefore often found to be quite difficult to raise the general level of transmission voltage. It might not be so difficult to accomplish both an increase in the transmission level and also in the primary voltage level if it were not for the fact that station transformers have been purchased in the past with voltage ratings to fit the local conditions at the time they were purchased and they were provided with taps to take care of such local conditions without much reference to the ratings and taps they should have to be properly used in an interconnected system. It is often found that to raise the level of the primary voltage it is necessary to adjust taps on all station transformers on the system. It is usually found that some of the older transformers are not provided with the proper taps to permit the raising of the voltage level and even if the ratios are satisfactory the voltage ratings of the transformers are so low that considerable over-excitation has been encountered. In order to eliminate this situation it is often necessary to shift station transformers around in the system until a fairly satisfactory setup is obtained.

In case of industrial power customers where the customer had installed power factor correction equipment, such as capacitors, in order to avoid a penalty for poor power factor, it has sometimes been necessary for the customers to install additional capacitor equipment in order to bring their power factor level back to the required figure, since increase of voltage lowers the power factor on induction motors. In the case of customer's lamps, it has generally been found necessary to raise the voltage level gradually and spread it over a period of at least six months, or preferably a year, in order to avoid excessive complaints of lamp burnouts.

The 3 phase 4 wire network situation has its own peculiar problem. One of the big objections to changeover to a 4 wire "Y" connected secondary system has been the problem involved in the operation of 220 volt motors on 200 volts. No particular difficulty is encountered with the majority of such motors, as over-motoring is quite common. However, in the case of fully loaded motors it has often been necessary to install auto-transformers. Elevator motors especially need auto-transformers because they are often located at the end of long interior circuits. It is quite generally necessary to change existing control equipment so as to operate properly on the lower voltage. Two hundred and thirty volt 2 wire heating equipment usually must be provided with auto-transformers unless the duty is such that the reduction in the speed of heating is not disadvantageous. Of course, there are some types of heating equipment which are designed for 115/230 volt 3 wire service. Such equipment, of course, can be operated satisfactorily on two phases and the neutral from a 3 phase 4 wire service, provided that the neutral can be connected in at all times. The problem is especially acute in the case of electric ranges as a result of the extension of 3 phase 4 wire networks or 3 phase 4 wire radial circuits into secondary business or residential districts. The use of electric ranges on these kind of circuits is rapidly increasing. This tendency was recognized a few years ago and an attempt was made to provide electric ranges with circuits and switches so designed that they could operate satisfactorily on "Y" connected circuits. Recently, however, there has been a trend in the other direction and the present tendency is to manufacture ranges which are not interchangeable between 3 wire single phase and 3 wire services off from 4 wire "Y" circuits. The use of heavy current consuming devices, such as air conditioning equipment is rapidly increasing and can be expected to become quite general. It should be appreciated that if any considerable amount of such equipment is installed on the lines in residential areas it will be necessary, if the load is to be handled satisfactorily and economically, to handle it on a 3 phase basis. The "Y" connected secondary system is undoubtedly the best solution to that problem. If its use in residential areas be-

comes quite general all of the thousands of electric ranges that are being sold today, designed on a non-interchangeable basis, will have to have a considerable amount of money spent on them to make them adaptable to the service. It would seem wise, therefore, to look ahead and sell only ranges which are interchangeable, and thus avoid the otherwise inevitable, but unnecessary, expense.

A fairly complete solution of all of the difficulties in connection with the extension of 3 phase 4 wire secondary systems would be obtained if the voltage level could be raised to 130/225 "Y". This is especially true of large power customers whose 3 phase loads are greatly in excess of their single phase loads. It seems to me that this particular problem should be studied carefully both as to whether it is practicable and as to whether it is economical. Fundamentally, there is no question as to its being economical, but it might require considerable expenditures in transformer equipment on some systems. I know of three systems which have been operating for a good many years on this basis with no difficulty whatsoever, as far as motor, heating and lighting equipment are concerned. Of course, it is necessary to use 130 volt lamps, but these are standard and they are at so near the upper level of standard lamp manufacture today that going to this voltage level would undoubtedly stop the tendency to use higher voltage lamps for many years to come and it might result in a final standardization at that level.

Utilization Voltage Standardization—A Plan of Action

By J. H. Foote

Supervising Engineer, The Commonwealth & Southern Corp., Jackson, Michigan

THE papers presented by Messrs. Monteith, Ogden, MacNaughton, Cole, Enos and Seelye have ably presented various aspects of the problem of utilization voltage standardization. The requirements and limitations of component parts of the rather complicated problem are clearly shown. Mr. Seelye has concisely set forth the problem as a whole, showing how definitely the requirements of the utilization equipment and the abilities of the distribution systems are inter-related. It remains only to suggest a procedure which will bring into play forces which will serve to correlate these requirements and abilities and to translate the results into suitable values of coordinated utilization voltages.

At the outset it is apparent that skillful compromise is an important key to the solution. Skillful engineering compromise is only possible when an adequate array of facts relating to both sides of the problem are available. The solution should become evident therefore, when adequate factual information as to the voltage requirements of utilization equipment, as related to abilities of distribution systems to supply voltage under conditions reasonably expected to exist, is made available for study. To outline a procedure which may be expected to produce this information is the problem at hand.

In attacking a subject embodying so many variables it seems wise to explore and to sample before penetrating too far toward final solutions. Trial balances of voltages under various conditions and for various systems may early indicate that assumptions have been fortunate or otherwise and may serve to guide further study without waste of effort. It would seem wise also to carry on such preliminary work in small groups to aid in concentration of effort and attention. Restriction of scope of activity of an individual group would also serve to focus attention and foster rapid delineation of that phase of the problem being studied.

It is therefore suggested that small groups of qualified men be designated, each group to attack but one phase of the problem initially, but to report progress when such is feasible. The groups should simultaneously work on related phases of a part of the general problem. For example, a study of single phase low voltage systems might first be made. Groups studying the necessary variation in customer service voltage in terms of per cent of normal should be organized. Economical and necessary variations should be determined for overhead rural and urban radial and network systems and for underground radial and network systems. Other groups studying voltage requirements of single phase utilization equipment should be designated. Motors of various sorts under conditions of starting and running, heating devices, radios, lamps and miscellaneous devices should be studied. Manufacturers would without question be glad to assist in the determination of these characteristics and requirements, and practical check tests on operating systems would serve to verify the results.

When these groups should have arrived at tentative values in terms of per cent variation in voltage above and below assumed bases a joint committee of the Transmission and Distribution and Electrical Equipment Committees would undertake to fit together these values to see if requirements of some equipment as regards permissible voltage variation is more rigid than has been determined to be economically possible by the groups studying system capabilities. Modifications in characteristics or ratings might then be in order. Eventually the spread of voltage variation needed by the supply system would be more, equal to, or less than, the spread allowed by equipment design. Having made the amplitudes of voltage variations of the same order, it is plain to see that the actual maximum and minimum voltages can be brought within similar limits and that design voltages, maximum voltages and minimum voltages can be agreed upon.

With the single phase aspects of the problem determined, at least tentatively, groups should probably attack the problem of three-phase equipment supplied from light and power networks having the two transformation ratios now in common use. Later, three-phase equipment of higher utilization voltage could be studied.

It is believed that a scheme of this nature involving a rather modest but courageous attack on a selected phase of the problem will guard against the dangers and discouragements inherent in standardization work of this nature and will effect a solution to a problem which has been recognized as perennial in the electricity supply industry.

Generator Insulation Tests

Progress Report, Generator Insulation Group, Apparatus and Design Division, Electrical Equipment Committee, E.E.I.

By B. Van Ness, Jr., *Sponsor*

Pennsylvania Water & Power Company

Presented before the Electrical Equipment Committee, E.E.I., Chicago, May 2

THE object of the study by the Generator Insulation Group is to investigate the possibility of developing practical, non-destructive tests which may be used to determine the operating condition of generator insulation and to locate points of weakness if the insulation is indicated to be in poor condition. It is realized that generator insulation is a complex combination of resistance, inductance, capacitance and leakage, and that it furthermore may be affected by temperature, moisture and the degree of cleanliness. In view of the difficulty of evaluating the various factors, it is probable that several tests or groups of tests may be required to obtain the desired information in a given case.

The program was initiated in 1935 by the presentation of Progress Report No. 1—"Investigation of Test Methods for Determining Operating Condition of Generator Insulation" by Mr. Dillard. The present working group took over the assignment in January, 1937. A suggested procedure for testing* was developed and circulated among the member companies with the request that such tests as facilities permitted, be carried out on machines which were to be scrapped or rewound. Through the cooperation of the operating companies thirty-four generating units, including those reported in 1935, have been tested:

Insulation resistance and dielectric absorption at 500, 1000 and 1500 volts	34 machines
Insulation resistance and dielectric absorption at 5000 and 15,000 volts	4 machines
Power factor measurements	15 machines
Ionization detection measurements	8 machines
Ionization discharge measurements	1 machine
Winding to ground high potential tests	11 machines
Turn to turn high potential tests	4 machines

Detailed reports on these tests have been presented periodically before this committee by the members conducting these tests. The purpose of this report is to summarize briefly the testing completed to date.

*E.E.I. Bulletin, Dec., 1937, P. 509.

A. Insulation Resistance—Dielectric Absorption—General

Insulation resistance has been used for many years as a general criterion of insulation condition. In view of this a thorough study is being made of the apparent insulation resistances of various types of windings and of the so-called dielectric absorption characteristics produced when the windings are charged from d.c. over periods of from one to ten minutes.

Insulation resistance of windings may be measured by meggers, megohmers, or voltmeters and micro-ammeters connected in series with the winding and source of direct voltage.

The megger has been found to give reliable readings if carefully calibrated, operated at speed and applied for a period sufficient to eliminate the electrostatic capacity effect of the winding. The contracted scale of the megger, in the upper values, has been found to be a disadvantage in making accurate measurements of insulation resistance. The higher voltage meggers are useful from this standpoint, as the scales are more open.

In order to eliminate as many of the varying factors as possible the majority of the data reported were obtained by means of a voltmeter, micro-ammeter and direct current from either a rectifier or a battery. For higher voltage tests Kenetron outfits have been used.

B. Insulation Resistance Tests at Moderate Voltages—500 to 1500 Volts

It has been found that the insulation resistance of a particular winding is affected greatly by many factors, such as age, moisture absorption, temperature, degree of cleanliness, composition of impregnating compound, composition and structure of the insulation, use of conducting paint on the outside of the coils, etc. Although spot readings have been used for many years to indicate the general condition of windings and although the insulation condition has been widely considered satisfactory if it meggers as much as one megohm for lower voltage machines and Rated Voltage ÷ 1000 for the higher voltage machines, it can be seen that spot readings without correlation to a definite base and without correction for such factors as temperature, humidity and dirt may be very misleading.

It has been demonstrated that the magnitude of the apparent insulation resistance of windings will increase with time of application of test potential. The supposition is that if the increase between one and ten minute readings is large, this is indicative of a winding which is dry and clean, but if the curve flattens out after one or two minutes it is an indication that the winding is either moist or dirty or both, or in deteriorated condition. Certain data gathered tend to support this theory; on the other hand other data are in direct conflict with the theory. There is needed not only additional data showing magnitude and slope of these curves, but more particularly information showing the variations in these curves over the life of the machines.

It is desirable that such insulation resistance readings be taken at temperatures as close to 75° as possible in order to secure an indicator of resistance at operating temperatures, eliminating the effect of humidity and requiring minimum temperature correction.

Tests have indicated that the insulation resistance of windings are affected very greatly by temperature. One group of tests on windings consisting of mica wrapper in the imbedded section and treated cambric end turns showed that the insulation resistance doubled for each 24° C. decrease in temperature (one minute 500 volt reading).

In a second group of tests the insulation resistance of a Class A varnished cambric winding decreased to 20% of its 26°C. value when the temperature was raised to 47°C. Further data are required to establish slopes of the temperature curve for various classes of insulation and various speeds and types of machines.

To date we have found that isolated

insulation resistance tests at 500 or 1000 volts will not consistently show up weak insulation on a high voltage winding even though it may have actually failed on potential tests. Such tests at 1000 volts will usually detect the winding failure if there is solid insulation between the breakdown terminals. However, if an air gap exists in the insulation circuit between these terminals even though it is very short, the insulation resistance tests cannot be relied upon to show positively that the winding is in trouble. Several insulation resistance tests did indicate, however, lowered insulation resistance together with decided flattening of the resistance time curves after the windings were deliberately damaged. It is possible that while spot readings with a megger or other device may not indicate any change in insulation resistance, the slope of the insulation resistance curve may show a decided alteration when the winding is in trouble. This type of test is particularly applicable where previous data are available for comparison.

It has been found that there was remarkably little difference between 500, 1000 and 1500 volts insulation resistance readings on machines in good condition. It is believed that such changes as may be found in insulation resistance with different values of voltage within the range of 500 to 1500 volts are due to the effects of moisture rather than of dielectric stress.

Based on the data submitted to date it appears that to obtain the maximum benefit from insulation resistance measurements a record of periodic observations should be kept on each machine with which subsequent measurements may be compared from time to time. It would seem advantageous to establish such a base when a new machine is first placed in service.

Basic data of absorption and curve slope have been taken on sixteen hydrogenerators and two turbo-generators. The windings of these machines will be checked periodically during the life of the units in order to obtain resistance life data. Similar basic data are being secured on five new turbo-generator windings installed during 1938. It is expected that insulation resistance checks will also be made on these windings periodically.

C. Tests with High Voltage D-C

One power company has been making tests since 1932, using 3000 volts d-c on 2300 volt machines and 8000 volts d-c on 6600 volt and 13,200 volt machines. With this method the important generators on the system are tested every six months and the record of microampere readings kept to determine any change in the condition of the insulation. The readings thus recorded are compared with the previous record of the machine and also with the readings obtained on duplicate machines in the same power house.

Several incipient failures on 2300 and 6600 volt machines have been detected by this method but none have been detected on 13,200 volt machines. This may be due to the fact that the d-c voltage is not as high in relation to operating voltage on this class of machine as it is on the lower voltage units.

High voltage insulation resistance tests on two units in good condition indicated only a slight decrease in insulation resistance with increase in voltage. Test results on another machine are given below. These include the varnished cambric insulated cable leads to the bus:

Kv. D-C	Insulation Resistance at 28°C. Megohms
5	32.2
10	28.5
12.5	26.6
15	25.9

An interesting phenomenon was noticed by one observer while making high voltage d-c tests using a Kenetron set. He reports that as the voltage was raised a complex high frequency discharge current was noticed on a cathode ray oscillograph, starting at approximately 1000 volts and increasing in magnitude as the voltage increase continued. This may have been due to parasitic discharges. Time did not permit a thorough investigation of this characteristic.

In general, it is felt that the field of high voltage d-c testing should be further explored.

Power Factor Test

Power factor tests of individual coils in the factory have been used for some time, with other tests, for manufacturing control of the insulating processes, but there is little information available on power factors of complete new windings. So far as is known, there is no information available regarding the variation of power factor with time on machines in the field. For this reason we have at present, no yardstick with which to compare our test data and it will be necessary to establish such a yardstick.

Power factor readings on generators as tested are shown in Table I.

TABLE I—SUMMARY OF POWER FACTOR TESTS

Type of Machine	*Rating kv-a*	*Voltage*	*Speed*	*Frequency*	*Insulation Age-Yrs.*	*Insulation Type*	*% Power Factor Armature*	*Field*	*Temperature °C.*
Vertical Turbo-Generator.....	17,500	7,800	720	60	30	A	11.0	—	22–32
Vertical Turbo-Generator.....	12,000	11,400	750	25	15	B	12.0	—	16–24
Horizontal Turbo-Generator.....	20,000	6,600	1,500	25	22	B	6.0	—	22–24
Horizontal Turbo-Generator.....	20,000	6,600	1,500	25	22	B	6.0	—	22–24
Horizontal Turbo-Generator.....	3,500	12,000	1,200	60	27	Composite	22–29	22–29	1
Horizontal Turbo-Generator.....	30,000	9,250	1,500	25	New	B	8–9	—	30
Horizontal Turbo-Generator.....	3,500	12,000	1,200	60	27	Composite	22–29 15.7	22–29	1
Horizontal Turbo-Generator.....	1,500	2,700	1,200	60	35	A	23.6	9–10.7	24
Horizontal Turbo-Generator.....	23,750	11,000	1,800	60	12	B	3.24	—	35
Horizontal Turbo-Generator.....	23,750	11,000	1,200	60	18	B	3.89	—	32
Horizontal Turbo-Generator.....	8,000	11,000	1,800	60	23	B	8.90	—	31
Horizontal Turbo-Generator.....	20,000	11,000	1,800	60	14	B	6.70	—	23
Horizontal Turbo-Generator.....	23,750	11,000	1,800	60	14	B	3.50	—	50
Horizontal Turbo-Generator.....	23,750	11,000	1,200	60	14	B	9.85	—	46
Horizontal Turbo-Generator.....	43,750	11,000	1,800	60	10	B	5.40	—	24

On one 2700 volt machine very extensive power factor tests were made. Inasmuch as the voltage rating of the machine was low it was possible to overstress the insulation with the available equipment and to observe the result on the power factor. All power factors were high, ranging from 15.7% at 1000 volts to 17.4% at 2700 volts and reaching as high a value as 23.6% at 3500 volts. Here the absence of basic reference data for this type of insulation made interpretation of these results difficult. The high power factor did, however, correlate with relatively low breakdown voltage.

In the majority of machines reported, there was found very little variation of power factor with voltage. It has not been possible to consistently correlate power factor with the dielectric strength of the insulation. On four machines which had very high power factors the dielectric strength was also very high.

Ionization Test

This test consists of subjecting the winding to various values of 60 cycle voltage and exploring the armature with a search coil to detect evidences of ionization. In the six tests made it was possible to definitely locate points of ionization and to measure ionization levels but the results of the tests indicate that high ionization does not necessarily mean low voltage breakdown, neither does low ionization indicate high dielectric strength. It is also possible that ionization may be altered by the removal of the rotor, which removal is necessary to properly explore the winding.

The test gave very little promise of usefulness because it was impossible to discriminate between external and internal ionization.

Ionization Discharge Measurements

On one machine an attempt was made to secure comparative measurements of ionization using an additional amplifier and measuring equipment. It was necessary to run these tests between the hours of 1:30 A.M. and 6:40 A.M. in order to eliminate electrical disturbances, vibration and noise. The following results were obtained.

1. The ionization point varied inversely with the temperature, ionization appearing at increasing lower voltage as the temperature increased.

2. Ionization with all three phases connected was less than for a single phase. This is believed to be due to the existence of ionization between phases which would not appear in the results with all three phases connected.

3. Ionization was not always linear nor was it directly proportional to applied voltage.

This test was not satisfactory and it does not appear at this time that it will be of value in generator insulation testing. It is difficult to interpret and extremely sensitive to outside interference.

60 Cycle Dielectric Strength

A summary of the insulation strengths of the various generators as tested is shown in Table II.

The puncture strength of the armature insulation on our particular tests was found to be about the same for potential applied with a constant rate of rise as for potentials of one minute duration applied in increasing steps with five minute intervals between such applications. The tests were made with the windings cold and the foregoing is only indicative that in the step tests the applied voltage did not heat the windings sufficiently to cause deterioration.

Insulation breakdown tests by themselves give a general picture of the strength of the windings and may indicate something of the balance between the strength of slot insulation and end turn insulation. In some of the tests the breakdowns were equally balanced between winding and slot, on others the slot insulation was very strong and could not be broken down. All failures on these latter machines occurred within the end turns.

A series of repeated tests on one 2700 volt coil made with ten minute rest periods between tests showed that after three tests the power factor increased for each succeeding test until the coil failed at a very much lower voltage than it had originally withstood.

During another series of tests in which a winding withstood 18 kv for one minute, a coil broke down on a straight line voltage application at 17 kv immediately thereafter. Here again the results are too few to draw definite conclusions but there is an indication that repeated application of voltage on deteriorated windings further deteriorates the insulation.

In general it will be noticed that the breakdown values reported in Table II indicate that the insulation strength of some of the machines was very much higher than would be expected of machines of the ages shown.

Conclusions

1. In our test work to date we have been unable to correlate 60 cycle breakdown strength definitely with any of the following non-destructive tests:

(a) Insulation resistance
(b) Slope of insulation resistance curves
(c) Power factor
(d) 60 cycle ionization

2. Insulation resistance varies widely with type and speed of machine, type and condition of winding, degree of cleanliness, temperature and humidity. "Spot" readings, particularly, may be misleading unless carefully corrected for various factors affecting the reading.

(*Continued on page* 231)

TABLE II—SUMMARY OF HIGH VOLTAGE BREAKDOWN TESTS

Type of Machine	*Rating kv-a*	*Voltage*	*Speed*	*Frequency*	*Insulation Age-Yrs.*	*Insulation Type*	*60 Cy. Breakdown-KV Armature*	*Field*
Vertical Turbo-Generator	17,500	7,800	720	60	30	A	46.0	1.8
Vertical Turbo-Generator	12,000	11,400	750	25	16	B	35.0	1.0
Vertical Turbo-Generator	12,000	11,400	750	25	15	B	45.0	3.7
Horizontal Turbo-Generator	20,000	6,600	1500	25	22	B	39.0	4.0
Horizontal Turbo-Generator	20,000	6,600	1500	25	22	B	43.0	5.5
Horizontal Turbo-Generator	3,500	12,000	1200	60	27	Composite	22.5-64.0	2.2
Horizontal Turbo-Generator	3,500	12,000	1200	60	27	Composite	30.0-62.0	1.5
Horizontal Turbo-Generator	1,500	2,700	1200	60	35	A	4.5-9.0	1.05
Horizontal Turbo-Generator	28,600	13,800	1800	60	11	B	16.8-30.6+	—
Horizontal Turbo-Generator	23,750	11,000	1200	60	18	B	17.0-35.0+	—
Vertical Hydro-Generator	15,000	13,200	94.7	60	12	B	28.0-38.0	—
Vertical Hydro-Generator	12,000	11,000	94.0	25	18	A	—	2.3

Economic Design of Overhead Primaries

By Paul H. Jeynes

Public Service Electric and Gas Company

Presented before the Transmission and Distribution Committee, E.E.I., Chicago, May 3

THIS paper is an outline of the method by which the principles of economic design have been reduced to simple, practical form for the guidance of the men in immediate charge of the field work, as developed by Public Service Electric and Gas Company.

Studies of economic secondary design made by this Company resulted in formulation of a few definite recommendations for wire and transformer size, secondary layout, and provision for load growth. This fortunate result comes about through the peculiar interrelation of the costs involved, which operate in such a manner that the general conclusions are almost unaffected by any reasonable variation in cost assumptions; for example, doubling the assumed cost of losses, or omitting losses altogether, affects the answer hardly at all.

In the case of primaries, however, not only are there no such compensating factors in the costs, but as Mr. MacNaughton has observed, alternate procedure suggests themselves at almost every step. For this reason, no attempt has been made to lay down rigorous instructions for primary design. Instead, it is recognized that determination of the most prudent design involves a combination of the detailed knowledge of local conditions and trends—possessed by the field engineers—with the analytical studies of system costs which the general office technical staff is in better position to make. The importance of engineering judgment in the field has therefore been emphasized, and material necessary to facilitate exercise of that judgment has been assembled and thoroughly discussed with the men who will apply it.

Basic Cost Data

Foundations for this procedure were laid at two round table sessions, when agreement was reached on the fundamental cost assumptions. This was not difficult so far as first costs of equipment, installed, were concerned. Reduction of capital costs to corresponding annual expense involved more discussion, and it was found that the field men were able to contribute particularly to the estimates of relative maintenance costs and salvage values.

It will be seen that the final data are based on only one price for copper—14 cents (weatherproof wire base)—though the curves can be quickly adjusted to any other cost. This simplification, we believe, is justified by the view that this problem of economic choice is to estimate the probable effect of an incremental investment on rates throughout the life of that investment; in other words, a meticulous analysis of present costs is not required so much as a thorough understanding of the long-term effect.

In this connection, particular attention was paid to the estimate of retirement expense, in order to tie it in with the actual charges per Company's financial statements, and to dispel any suspicion that the item is merely a theoretical allowance made on an arbitrary basis.

Still more discussion was involved in the matter of evaluating copper losses. It was finally decided to carry out the computations for three values for cost of losses, which we prefer to express in "dollars per year per kilowatt of peak losses":

A. A maximum figure, which includes an allowance for demand charges, and which also approximates the conditions for "recommended estimate" of cost of losses in combination with bare wire.

B. A minimum figure, which includes no demand component, and which also approximates the conditions for "recommended estimate" of cost of losses when a charge is included for withdrawal of existing smaller wire.

C. A "recommended estimate," which includes an allowance for incremental cost of facilities whose capacity might, over a long period, be affected by the amount of losses.

The choice between A, B, and C in practice will be discussed a little later. One or two comments on our study of loss evaluation may be of interest.

In the meeting of the Transmission and Distribution Committee for April 18-19, 1935, the view was taken that the cost of losses should be considered to be the simple incremental energy cost. For the present purpose, we believe that this minimum value is a trifle low, for the reason that application of such a figure would lead to use of smaller conductors for a given load, which would accentuate the effect of voltage drop. Now the maximum load that can be handled by a single circuit is, in Public Service territory, frequently a function of the tolerance in voltage drop from the first transformer to the last transformer. A reduced economic wire size would therefore advance the date of relief by additional circuits, or make necessary earlier reinforcement, installation of pole-type regulating equipment, etc.

On detailed investigation, the "minimum" estimate was established at a higher value than might be anticipated. Copper losses on residential or commercial lighting circuits occur, in the Public Service system, very largely during the system peak, so that small incremental losses are generated almost wholly by the marginal generating equipment, whose incremental energy cost is several times the annual system average. The low average results from operation of efficient base-load units, plus dump power and economy flow obtained via our interconnections, but the bulk of the incremental copper-loss energy is not obtained from these sources.

Another interesting coincidence was the discovery that this figure for cost of losses is confined to a fairly narrow range for the several classes of service, despite the difference in load characteristics and the variation in incremental energy costs from hour to hour. This results from the fact that, in the Public Service system, those loads which have the lowest annual capacity factors involve generation of loss energy during the periods of highest marginal cost.

A large number of load curves were analyzed to arrive at typical load and loss factors for this application. Annual load factors for the several classes of service vary from 28 per cent to 51 per cent; the corresponding loss factors range from 13 per cent to 30 per cent.

In presenting this material, values

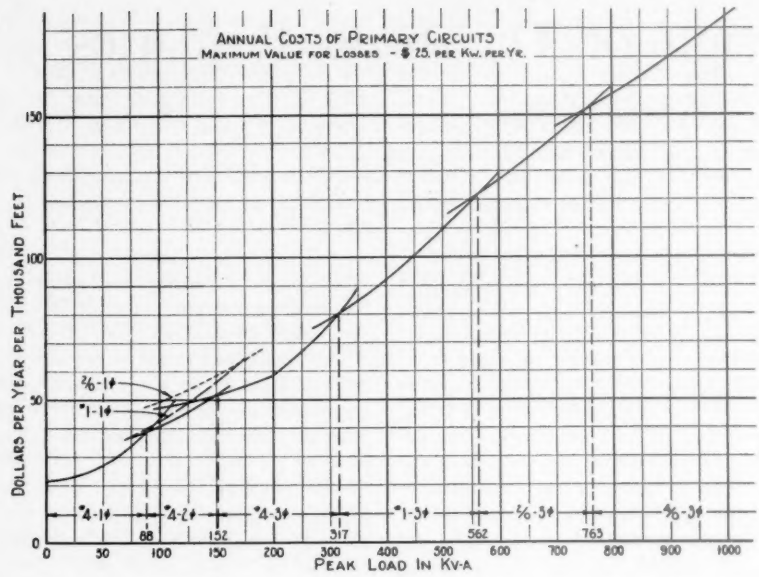


Fig. 1

have been assumed for the three evaluations of losses as follows:

A. Maximum estimate, $25 per kilowatt per year.

B. Minimum estimate, $10 per kilowatt per year.

C. Recommended estimate, $19 per kilowatt per year.

It must, of course, be understood that these figures are not assumed to be generally applicable, and were selected only to illustrate the procedure. Perhaps it will appear that little confidence can be placed in data so uncertain that the "recommended" value is practically double the minimum. But it will be observed that the curves of annual cost are fairly flat; for example, if the $10 figure is correct, and the maximum loading on No. 4 wire is erroneously based on a $19 value, the penalty for this underloading will amount to $9.00 per year per thousand feet of circuit, which is less than 5 per cent of the annual cost of one thousand feet of typical circuit, poles plus wire plus losses.

Form of Presentation

Conclusions have been presented in the form of a brief table (Table I) supplemented by three curve sheets (Figs. 1, 2, and 3), reproduced here. Referring to Table I, Column B (losses at $10) is used when the work involves removal of existing wire; Column C (losses at $19) is used for new extensions; Column A is used for bare wire, though originally included principally to show the effect of extreme values for losses.

Computations were based upon allowance for costs of wire and losses only; if differentials in costs of poles, etc., are to be expected, an additional allowance must be made. Perfect balance, polyphase, is assumed.

The curve sheets are most useful in estimating other than typical cases by sketching in parallel curves for other assumptions, or for estimating the penalty for loading either side of the intersecting points. They also show that single-phase branches larger than No. 4 are not advisable, no matter what losses are worth.

Peak load values used as the index refer to the fifteen-minute peak on a typical day in the peak month. For example, a typical December day is selected for residential loads rather than the Christmas Eve or New Year's Eve loads, which are sometimes more than 20 per cent higher.

When this material was reproduced for distribution to the field engineers, an appendix was attached covering several questions that had been raised in the course of the general discussion. One such referred to the difference between the present method and the classical application of Kelvin's law; another was concerned with the method of computing losses—whether a uniformly distributed load should have been assumed. The discussions are not of sufficient importance for reproduction here, but served only to correlate our procedure with the information that the field men had previously obtained from text books or other sources.

Bare Wire Primaries

All of the foregoing cost data are based on the use of weatherproof wire, plus a nominal amount of tree wire. A limited number of bare wire installations have been made in the Public Service system, and the effect of the lower first cost is a matter of interest. It appears that the ranges of economic loading for bare wire with losses at $19 are almost identical with the values for TBWP wire and losses at $25. The latter are therefore used as a convenient index.

Economic Replacement of Undersized Conductors

The conclusions of Table I were obtained by comparing annual costs of one installation with the annual costs that would have resulted if another wire size had been chosen. It is a slightly

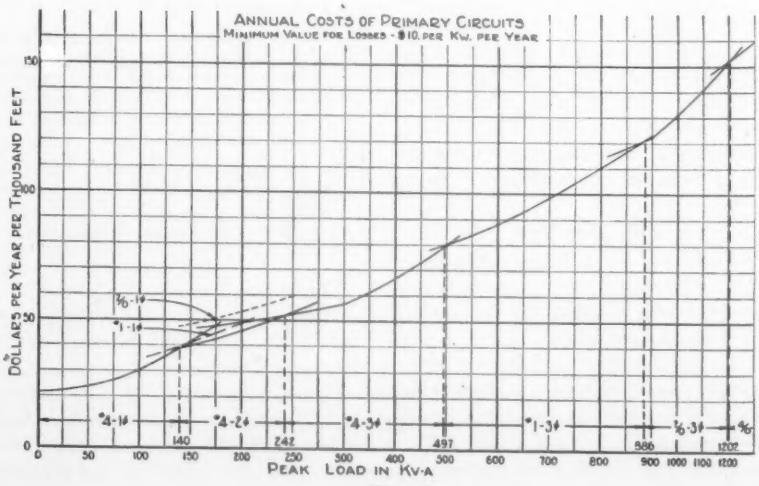


Fig. 2

different problem to find the load at which an existing installation should be replaced by larger wire, because the costs of removal enter into the equation.

If the wire already in place is in good condition—i.e., it is not about to be replaced for reasons other than load growth—it may be anticipated that about 80 per cent of it can be removed and returned to service elsewhere without sacrifice of its earning power or reduction of its normal life. However, certain expenses are incurred by reason of the premature withdrawal which may be summarized as follows:

1. The first cost, installed, of the 20% junked, less net salvage, is charged to the retirement reserve account immediately, instead of at some future date (as would be the case if it were left in place).
2. The labor cost of originally installing the 80% reused must be withdrawn from the capital accounts, and is ultimately charged to retirement expense; likewise the labor cost of its removal. Neither expense would be incurred at all if the wire were left in place. (It is assumed that the labor costs of reinstallation and ultimate removal are identical with the original cost of installation and removal, respectively).

The accompanying computation sheet illustrates the procedure as applied to an existing three-phase four-wire No. 4 circuit which is about to be replaced by No. 1 wire, resulting in a penalty of about $9.75 per thousand feet for advancing withdrawals one year. This amount is added to the costs of the No. 1 wire before equating to the cost of the No. 4 wire, in order to find the load at which the transition becomes economic.

The effect of this adjustment on Table I is shown in this computation sheet.

It will be observed in the following tabulation that the effect on Column C (losses at $19) is to increase the load values almost to those of Column B, Table I (losses at $10). Since this results in postponement of the work for only a short term of years, there is furthermore justification for using a value for losses somewhat less than $19, which would bring the figures still closer. Hence our practical conclusion, that when replacements are to be made, Column B of Table I is the reference.

Computation Sheet I

Penalty for One Year's Advance in Date of Withdrawal

(1,000 circuit feet, 3-phase, 4-wire, #4 TBWP)

1. *20% of original plant junked.*

Net salvage of #4 wire is practically zero. Normal anticipated life 20 years. Interest taken at 7%.

Retirement annuity, 20 years at 7% = 2.44%.

The normal allowance of 2.44% is sufficient to cover ultimate withdrawal at age 20. If withdrawn earlier, a larger annuity should have been charged, and the unforeseen deficit must be made up by a charge at the date of actual withdrawal, amounting to first cost, less net salvage, minus the theoretical accumulated sinking fund.

The difference between the charge so computed in a given year, and the worth at that time of a similar charge which would have been incurred one year later if the withdrawal had been postponed one year, is the immediate penalty for one year's advance in date. This difference, for consecutive years at several ages is tabulated below:

I	II	III	IV	V
Age in Years	*Accumulated Sinking Fund*	*100% minus Col. II*	*"Present Worth" of Col. III in Previous Year*	*Penalty (= Value from Col. III in first year, minus Col. IV)*
5	14.03%	85.97%		
6	17.45	82.55	77.51%	85.97-77.51 = 8.46%
10	33.70	66.30		
11	38.50	61.50	57.75%	66.30-57.75 = 8.55
15	61.30	38.70		
16	68.03	31.97	30.02%	38.70-30.02 = 8.68

Since the above percentage is applied to only 20% of the original investment, the penalty for one year's advance in date of withdrawal, at any age, is very nearly .20 × 8.6% = 1.72% of the first cost, installed.

2. (a) Labor cost of original installation.

For #4 wire, about 38.5% of the total cost, installed. This is applied to only 80% of the original cost, or .80 × 38.5% = 30.8% of the original cost, installed.

One year's postponement of this expense is worth .07 × 30.8% = 2.16% of the first cost.

(b) Cost of removal.

For #4 wire, about 11.5% of the total cost, installed.

One year's postponement is worth .07 × 11.5% = .81% of the original cost, installed.

Summary

The total penalty:

1	1.72%
2 (a)	2.16
(b)	.81
	4.69% of first cost, installed.

For 1,000 feet of #4, four-wire circuit this will amount to approximately $9.75.

Table I—Economic Types of Primary for Various Loads

(Weatherproof Wire; 2400/4150-Volt System)

Type of Primary	*Peak Load in Kv-a*		
	A. Losses at $25 per kw per year	*B. Losses at $10 per kw per year*	*C. Losses at $19 per kw per year*
#4, 1-phase	Under 89 kva	Under 140 kva	Under 101 kva
#4, 2-phase	89-160	140-250	101-182
#4, 3-phase	160-317	250-497	182-360
#1, 3-phase	317-562	497-886	360-641
2/0, 3-phase	562-763	886-1202	641-871
4/0, 3-phase	Over 763	Over 1202	Over 871

Relative annual costs are here the only criterion; voltage regulation and other practical considerations have been ignored. Perfect balance, polyphase, is assumed.

Of course if the wire withdrawn is so old that it cannot be reinstalled, the larger penalty of about 8.6 per cent of first cost is suffered. Jobs of this type are frequently of sufficient importance to make a specific estimate, but the procedure is identical.

	B. Loss at $10/kw		*C. Loss at $19*	
Wire Size	*New Construction (Table I)*	*Adjusted for Withdrawal*	*New Construction (Table I)*	*Adjusted for Withdrawal*
#1	497-886 kv-a	588-1,040 kv-a	360-641 kv-a	427-756 kv-a
2/0	886-1,202	1,040-1,455	641-871	756-1,055
4/0	Over 1,202	Over 1,455	Over 871	Over 1,055

Anticipation of Load Growth

It is generally acknowledged that in determining the economic conductor size it may be necessary to anticipate load

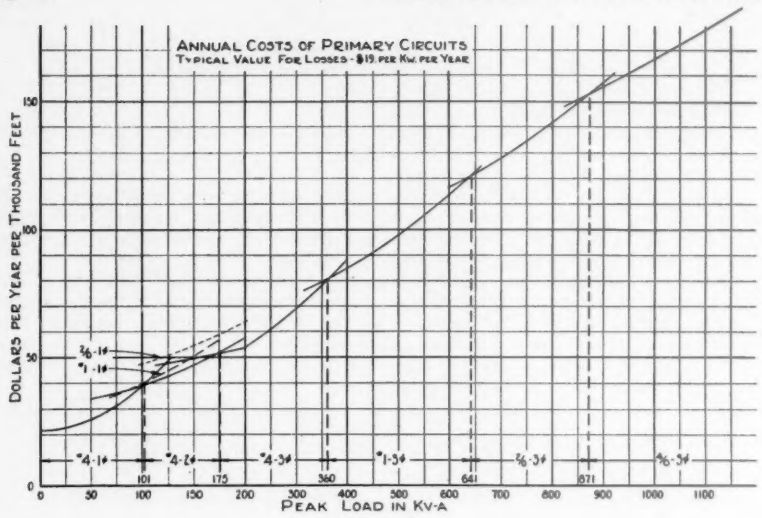


Fig. 3

growth to some extent in order to avoid the extra expense involved in returning to one location at short intervals to make piecemeal reinforcements. The following discussion indicates that no considerable anticipation of growth can be justified unless the temporarily improved losses (i.e., the better voltage resulting therefrom) would serve to postpone expenditures elsewhere on the circuit. Calculations for a typical case are reproduced in detail in the material supplied to the field engineers, so that adjustment can be made easily to fit conditions other than those assumed.

The problem may be outlined as follows:

Consider a three-phase main of #1 wire at the point where it tapers down to #4, and assume that the first few sections of #4 are carrying more than 497 kv-a, so that reinforcement is justified per Column B of Table 1. How far should the reinforcement be carried beyond the last section carrying 497 kv-a, in anticipation of load growth?

A net penalty of course results from use of the larger wire during the initial period before a peak of 497 kv-a is carried, which is equal to the difference in annual costs of the investment minus the difference in annual costs of losses. That penalty must be offset by the saving which results from doing the work as one job, rather than piecemeal as the increased loads require. It is the evaluation of this saving which presents the difficulty.

Ordinarily, there appears to be a tendency to overestimate this saving. Our figures for typical first costs of wire, installed, include an allowance for truck time and storeroom costs which amount to about 9% of the total cost of the wire, installed. If a given extension is completed in two jobs, rather than one, part of such costs will be duplicated; that is, the view may be taken that the *incremental* cost of extensions beyond the theoretical limit (the section carrying 497 kv-a at peak) would be less than the *average* figure used to determine that limit. Ordinarily, not all of the automobile expense will be duplicated, so that the difference between the average and incremental cost will be

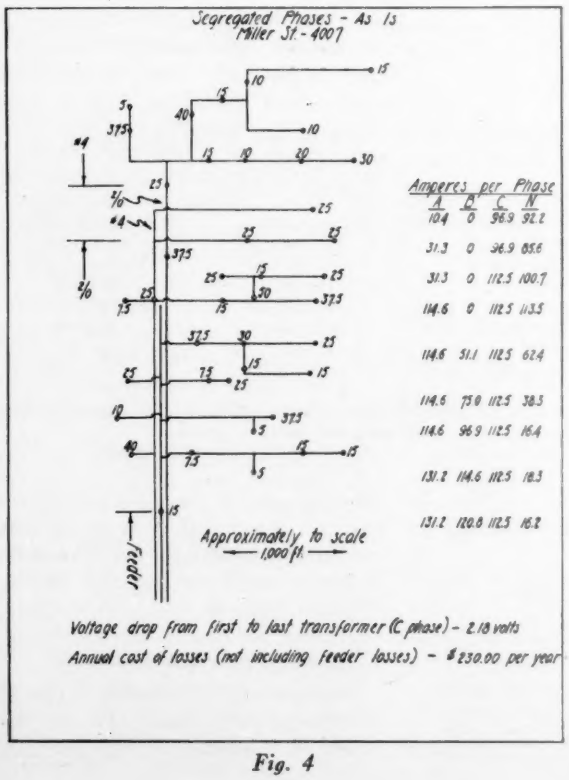

Segregated Phases - As Is
Miller St. - 4007
Amperes per Phase
A B C N
10.4 0 96.9 92.2
31.3 0 96.9 85.6
31.3 0 112.5 100.7
114.6 0 112.5 113.5
114.6 51.1 112.5 62.4
114.6 73.0 112.5 38.3
114.6 96.9 112.5 16.4
131.2 114.6 112.5 18.3
131.2 120.8 112.5 16.2
Approximately to scale
1,000 ft.
Feeder
Voltage drop from first to last transformer (C phase) - 2.18 volts
Annual cost of losses (not including feeder losses) - $230.00 per year

Fig. 4

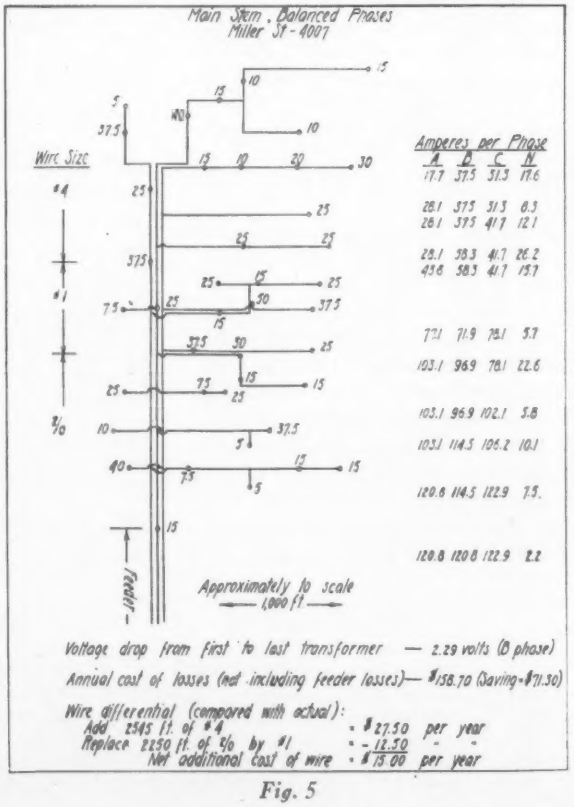

Main Stem, Balanced Phases
Miller St. - 4007
Wire Size
Amperes per Phase
A B C N
17.7 37.5 51.3 17.6
28.1 37.5 51.3 6.3
28.1 37.5 41.7 12.1
28.1 58.3 41.7 26.2
45.6 58.3 41.7 15.7
77.1 71.9 78.1 5.7
103.1 96.9 78.1 22.6
103.1 96.9 102.1 5.8
103.1 114.5 106.2 10.1
120.6 114.5 122.9 7.5
120.8 120.8 122.9 2.2
Approximately to scale
1,000 ft.
Feeder
Voltage drop from first to last transformer — 2.29 volts (B phase)
Annual cost of losses (not including feeder losses) — $158.70 (Saving - $71.30)
Wire differential (compared with actual):
Add 2545 ft. of #4 : $27.50 per year
Replace 2250 ft. of 1/0 by #1 : - 12.50 " "
Net additional cost of wire : $15.00 per year

Fig. 5

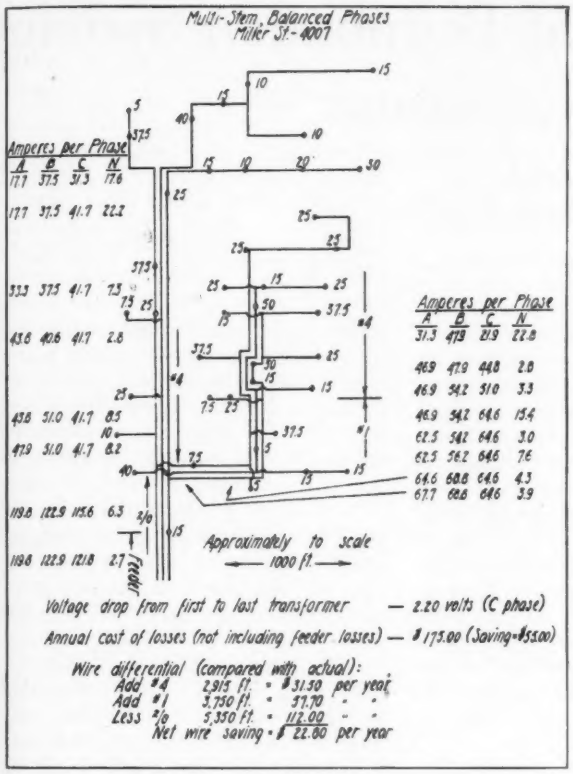

Multi-Stem, Balanced Phases
Miller St.-4007
Amperes per Phase
A B C N
Amperes per Phase
A B C N
Approximately to scale
1000 ft.
Voltage drop from first to last transformer — 2.20 volts (C phase)
Annual cost of losses (not including feeder losses) — $175.00 (Saving=$55.00)
Wire differential (compared with actual):
Add #4 2,915 ft. @ $31.30 per year
Add #1 3,750 ft. @ 31.70 " "
Less 2/0 5,350 ft. @ 112.00 " "
Net wire saving = $ 22.80 per year

Fig. 6

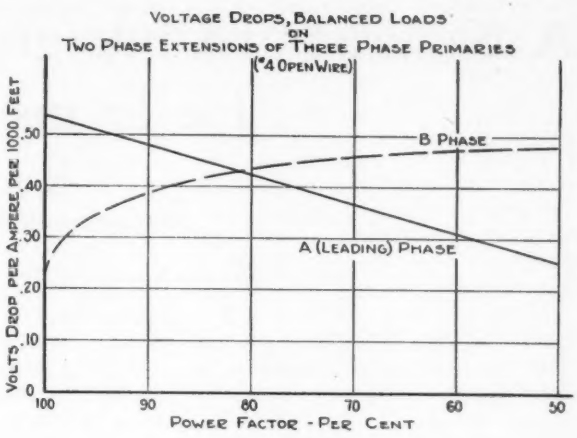

Voltage Drops, Balanced Loads
on
Two Phase Extensions of Three Phase Primaries
(#4 Open Wire)
B Phase
A (Leading) Phase
Volts Drop per Ampere per 1000 Feet
Power Factor - Per Cent

Fig. 7

less than 9% of the former; for purposes of illustration 5% has been assumed.

It is appreciated that this method, applied to a specific illustration, is not at all precise, but it does serve to demonstrate that it does not pay to anticipate load growth very far in advance.

On this basis, it is found that the reinforcement may be extended beyond that section carrying a peak of 497 kv-a down to the one carrying 458 kv-a. This means anticipation of growth amounting to $\frac{497-458}{458} = 8.5\%$, or about one year's increase.

The percentages similarly obtained for other sizes of conductors are as follows:

2/0, replacing #1	10.7%
4/0, replacing 2/0	11.2

As a result of this investigation, the general rule has been developed that not more than two years' growth should ordinarily be anticipated.

Primary Layouts

The three-phase four-wire primaries which are now standard construction in the Public Service system were in many cases the product of evolution of combination of earlier single-phase and two-phase circuits, as their layout reveals. A discussion of the relative merits of the several distinct types of layout (balanced phases along a main stem, multiple stems, and segregated phase areas) is perhaps not a matter of great general importance, but our peculiar conditions give it sufficient interest to warrant inclusion in this material. Several actual circuits were analyzed to show the relative costs and voltage regulation that could be expected from the different arrangements of feeder and branches. A set of three sheets showing the application to a particular circuit is attached. (Figures 4, 5 and 6.) The general conclusions arrived at were summarized as follows:

(a) Balanced phases, main stem.

The most economical type of main from the feeder out to a point beyond which the peak load is about 182 kva.

(b) Balanced phases, multi-stem.

Ordinarily not justified unless equal lengths of side branches are eliminated by the extra length of main. Sometimes an economical method of improving voltage.

(c) Segregated phase areas.

Serves to reduce the voltage drop from first to last transformer on each phase, but usually at the expense of heavy single-phase branches and unbalanced loads in mains. Usually not economic when applied to loads of this magnitude.

Economic Apportionment of Voltage Drop Between Primary and Secondary

So far as the operations of the field engineers are concerned, the only instruction necessary as to voltage drop is a statement of the permissible limits. However, in discussions of this kind, the question of economic apportionment to primary and secondary of the total allowable drop is always brought up, and a brief study of the matter was therefore included with the other data.

Primary regulation, in the Public Service System, is such that the voltage spread within the circuit—*i.e.*, the maximum drop from first to last transformer—shall never exceed 3%. Secondaries are so designed that the maximum steady-state voltage drop shall not exceed 4.5%, including transformer and secondary lines. The "ideal" primary may be defined as one which, designed on the basis of the foregoing rules for best economy, would give exactly 3% drop at peak load. Whether this ideal can be realized depends upon the load density in the area served; if the density is less than ideal, the voltage drop on a primary so designed will be excessive, while a greater density would result in less than 3% drop and would permit an increase in the secondary voltage tolerance. Since the latter would theoretically improve secondary costs by $0.20 per kv-a annually for 1% increase in the voltage limitation, the question is raised whether overall costs could be reduced by deliberately increasing primary wire sizes over the economic values previously determined in order to realize this improvement.

(*Continued on page* 222)

A New Semi-Underground Distribution System for Evansville, Indiana

By E. V. Sayles

The Commonwealth & Southern Corporation

Presented before the Transmission and Distribution Committee, E.E.I., Chicago, May 4

EVANSVILLE, Indiana, a city of some 110,000 inhabitants, is located on the Ohio River, the southern boundary of the state of Indiana. Electric service for Evansville is furnished by the Southern Indiana Gas & Electric Company principally from a steam generating station on the Ohio River. The primary distribution system consists of 3 phase, 4 wire, 4160 volt overhead feeders which are supplied from several substations, which, in turn, are served by 12,000 volt lines from the main generating station. With few exceptions, all of the lines are overhead.

The principal business district of the city comprises an area approximately two blocks wide and seven blocks long. The principal thoroughfare is Main Street and the overhead distribution system serving the district is carried on wood poles in the narrow alleys which parallel Main Street and cross-streets and which, because of their width, are very congested by vehicular traffic serving the various business establishments.

Early in 1937 the load in this area was approximately 4000 kva, and was served by several 4160 volt overhead feeders from the Division Street Substation, which is located about one mile from the load center of this area. In each of the main alleys of the area there was at least one 4 wire, 4160 volt primary circuit and, in addition, there were single phase circuits serving street lighting and sign lighting load. In spite of the congestion of overhead wires in the alleys, very good service has been maintained. However, there is no further room in the alleys for the addition of circuits to provide for load growth resulting from increases in lighting, refrigeration, air conditioning, etc. As a result, it was decided early in 1937 to adopt a program of gradually replacing the present overhead system with new facilities which would have greater capacity and reliability and at the same time relieve congestion in the narrow alleys.

A rather extensive study was made based on serving an ultimate load of 12,000-15,000 kva in an area approximately four blocks wide and eight blocks long. Obviously, the study contemplated that the bulk of the principal primary distribution circuits should be placed underground if possible. Consideration was given to primary voltages of 12,000 volts and 4160 volts, both of which are common voltages in the distribution system. Also, consideration was given to both the radial and the network types of systems. As a result of this study, it was decided to proceed with the installation of a 4160 volt radial primary system, the construction to be carried out on about a four-year program.

Present Conditions

In general, each block in the business district has two alleys about 12 feet wide at right angles to each other and intersecting in the middle of the block. Located at or near the junction of these alleys are transformer platforms supported on the overhead line poles and upon which are mounted lighting transformers, power transformers, and transformers used for street lighting and sign lighting. The secondary circuits from these racks are carried on the same poles with the primaries.

In these alleys there is also an underground duct system not in use for many years, consisting of 3¼ inch multiple clay tile ducts in a 3x2 arrangement. Although this duct system was installed about 25 years ago, a thorough inspection disclosed it to be in good condition, there being relatively few places in need of repair. In the center of each block there are small manholes, approximately 4 feet deep and 4 feet square, which are also in fairly good condition. In many of these alleys there are also steam heating mains, sewer mains, and telephone and telegraph ducts. The steam mains are, in most cases, located on one side of the alley and the power ducts on the other, so that with proper maintenance

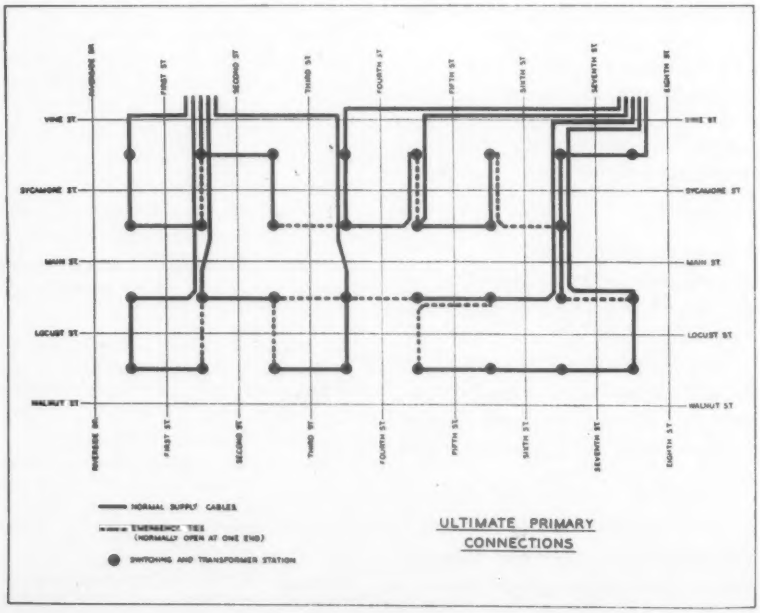


Fig. 1

of steam mains there should be no undue heating of any cables in the power ducts.

General Plan

The general plan of distribution as adopted for this area provides for 4160 volt underground primary circuits supplying separate lighting and power transformer banks located at the alley intersections near the centers of the blocks. Each primary circuit consists of a 350,000 cm, 3 conductor, 7x4/64, IPLC cable from the substation to the downtown area. Each of these circuits is rated at approximately 250 amperes and several transformer banks are supplied from each circuit. In order to provide sectionalizing facilities for each transformer bank in case of cable failure, specially designed switching stations are installed in the alleys adjacent to the transformer locations. The ultimate plan calls for the installation of approximately 32 switching stations to be served by approximately ten 4160 volt underground circuits, half of these circuits to be supplied from the Division Street Substation and the other half from a new substation to be located near the northwestern section of the business district. Figure 1 is a one line diagram of the ultimate system connections.

Although each of the primary feeders is essentially a radial circuit, the emergency tie connections (shown on Figure 1 as normally open at one end) provide the equivalent of non-automatic loop operation when necessary. Such a system should be highly reliable since experience indicates very little trouble in modern cable installations of this type and voltage.

On account of the congestion of the various sub-surface facilities in the narrow alleys, the use of underground vaults for switching and transformer equipment was not considered practicable. Further, due to flood conditions such as were experienced during the Ohio River flood of 1937 when the area was covered with water for several days, it was considered desirable to keep transformers and switching equipment above high water, if this could be done in a practicable manner.

For these reasons, designs were prepared for suitable overhead switching equipment to be mounted along the sides of the alleys well above the ground. Each switching station is connected to the underground system by cable risers, and connections from the station to the overhead transformer platforms are made with aerial cable supported on a messenger. One such switching station is installed in each block, each station consisting of two non-automatic manually operated oil circuit breakers and a primary sectionalizing box with four oil type fuses mounted in the top of the box. The fuses (one for lighting and three for power) are used to serve the main transformer banks, and provision is also made in each box for two extra sets of disconnecting devices so that two additional circuits can be taken from each station if desired.

Five stations of this type were in-

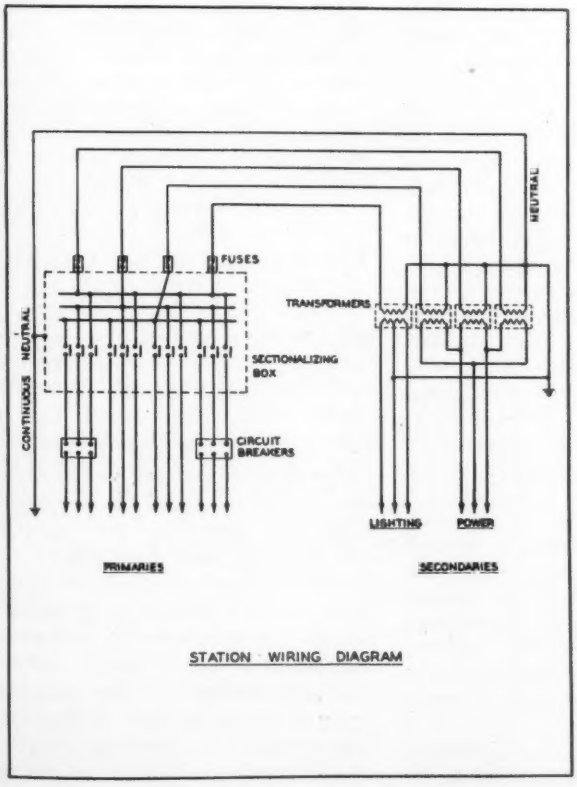


Fig. 2

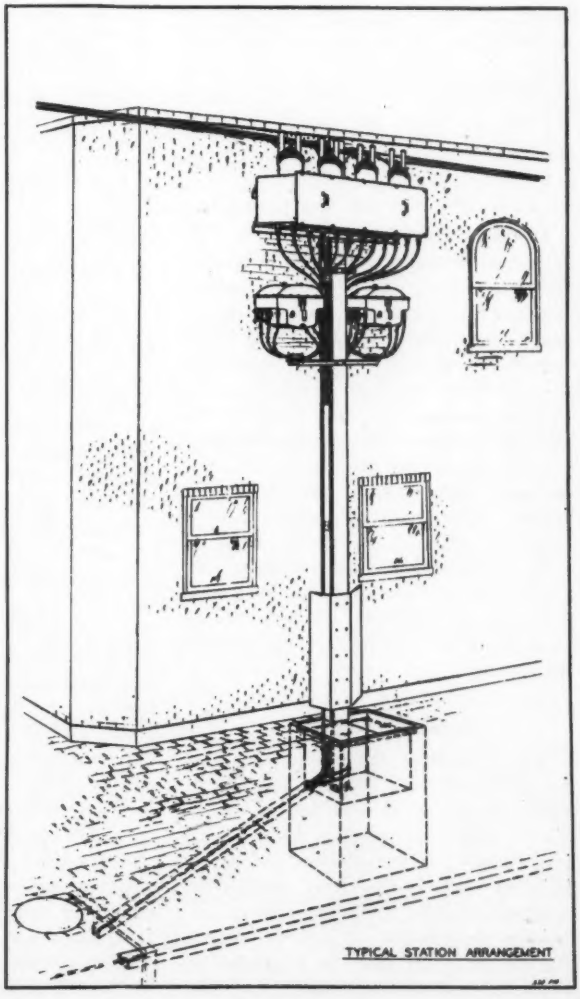


Fig. 3

stalled in 1937 and seven are being installed in 1938. These twelve stations are served by four 4160 volt underground cable circuits from the Division Street Substation and as additional stations are installed to serve more of the present load from the underground primary system, additional underground primary cables will be extended into the area.

Since the present manholes are very small and the present multiple ducts are none too large for the installation of the 3 conductor 350,000 cm cables, it was necessary to change to single conductor cables in the downtown area. Therefore, a trifurcated joint was installed in the last large manhole where the circuit enters the multiple duct. From this manhole to the first switching station of the circuit, three single conductor, 350,000 cm, 8/64, IPLC cables were installed. All of the remaining underground cable in the downtown area beyond the first switching station on each circuit is 4/0. The three single conductor cables are installed in one duct, these cables being pulled directly from one switching station to the next through the old manholes and, in most cases, without splices.

Street and Sign Lighting Circuits

In connection with this work, it was, of course, necessary to eliminate the special overhead circuits which supplied individual transformers serving the multiple street lighting and sign lighting systems. This was done by connecting the multiple lighting directly to the lighting transformers installed at the alley intersections, these various connections being made through RCOC secondary switches located near the transformer installations and controlled by means of pilot wires which were, in turn, controlled by time switches installed near the center of the load area. The pilot wires consist of lead covered control cables installed in the present duct system.

Secondary Construction

The immediate construction program for 1937 and 1938 does not include the rehabilitation of the secondary system. Future plans, however, provide for the installation of secondaries along the building walls in the alleys, using three conductor cable. This method of extending secondaries has been in successful use for many years in a number of cities and has been very satisfactory. The present transformer platforms which are supported on the wood poles and which span the alleys will eventually be replaced by modern steel structures either spanning the alleys or arranged parallel with the building walls.

Description of Stations

One switching and transformer station is installed in each block, adjacent to the building walls at the intersection of the alleys. Figure 2 is a wiring diagram of a typical station. The switching station, as previously mentioned, consists of two manually operated oil circuit breakers and a primary sectionalizing box. The box is mounted about 18 feet above the ground on an 8 inch steel "H" column and the two oil circuit breakers are mounted directly below the box about 14 feet above the ground. The base of the column is secured by anchor bolts to a reinforced concrete foundation so that the entire structure is self-supporting. In the concrete base there is also a handhole with ducts connecting to the adjacent manhole so that the cables can be extended from the manhole to the handhole, up the "H" column to the circuit breakers, and then into the sectionalizing box. Figure 3 is a view of a typical switching station.

The primary sectionalizing box is about 5 feet long by 20 inches high by 20 inches deep, the front of which is removable. The entire box can be made air tight so as to prevent the entrance of air due to expansion or contraction occasioned by changes in temperature. An air valve is provided on the side of the box to check tightness. All bolts, nuts, screws, pins and miscellaneous small hardware used on the primary box, circuit breakers, and fuses are made of Everdur metal so as to preclude any possibility of corrosion.

In training the cables up the "H" column and into the circuit breakers and primary box, maple blocks were used to clamp the cables and support them properly. Cover plates are provided for the sides of the column and a steel guard plate is fastened to the bottom of the column so as to protect it from traffic in the alley. A removable platform was also designed to be fastened to the "H" column to facilitate installing the equipment and making the cable connections. For maintenance work, a truck with a specially designed platform can be driven under the equipment and any work performed readily from this truck.

The circuit breakers, sectionalizing boxes, and oil fuses were supplied by the G. & W. Electric Specialty Company. The breakers are designated as Type K, 300 amperes, 7500 volts, and the fuses are Type FC42, rated 200 amperes, with an interrupting rating of 25,000 kva. In order to insure these fuses being adequate for maximum short circuit conditions, reactors are installed in the main feeders at the Division Street Substation.

The aerial cable used at present from the fuses on the top of the primary box to the transformer racks is No. 2 copper, single conductor, Anaconda "Super-Duracord" sheath with 12/64" ACR (Anaconda corona resisting) insulation. This Duracord sheath is a tough bakelite-dipped braid with good abrasion resisting qualities. Four conductors are cabled together with marlin twine and hung from a No. 0 copper messenger which is supported on brackets on the building walls where necessary. This messenger also serves as a neutral conductor. These aerial extensions are relatively short, averaging approximately 30 feet each.

Summary

This new distribution system for the Evansville business district can be briefly described as comprising underground radial primary circuits with throw-over facilities to adjacent circuits, and with overhead switching and transformer equipment and overhead cable-type secondaries. It is believed that it meets the problems peculiar to this area in a very satisfactory manner at a minimum cost, and can readily be expanded to provide for a substantial growth in load.

The Future of the Utilities

(*Continued from page* 190)

stimulate the great electric manufacturing industry and the steel industry and many other industries. Industry is a revolving chain, every strong link in which helps the whole wheel go around.

However all this may be, I think I have demonstrated that the investments which your banks have made are safe and that you can safely continue the practice of investing in the senior securities or the high-grade bonds of carefully selected operating electric companies, gas companies, and of electric and gas companies combined. It does not seem to me to be too much to say that they compare quite favorably with any other class of security in which by law savings banks may invest.

Coordination of Electric Power and Transmission Facilities in Wisconsin

By L. F. Seybold

Assistant Vice-President, Milwaukee Electric Railway & Light Co.

Presented at the Dinner Meeting, E. F. I. Engineering Committees, Chicago, May 3

MY SUBJECT deals with the coordination of power facilities in Wisconsin. Under ordinary circumstances it would be of interest to your five engineering committees as a review, from an engineering standpoint, of the growth of electric power facilities in one section of the country. Governmental supervision on a national scale over this development, however, has made the subject of concern to the electric light and power industry. I refer to the implications of the Federal Power Act of 1935 for federal supervision over the division of the country into regional districts for the voluntary, but not compulsory, interconnection and coordination of facilities for the generation, transmission, and sale of electric energy. According to the act this regional supervision is for the purpose of assuring an abundant supply of electric energy throughout the United States. Whether we like it or not we cannot afford to be disinterested in this matter. The industry looks to its engineers for assurance that facts will be accurately and properly presented.

I believe that the study of coordination of power facilities in Wisconsin will in some respect be of interest to you. Less than 56 years ago, the first residence in the world ever to be lighted by electricity from a hydro-electric plant was served by a small dynamo located in a paper mill on the Fox River in Appleton, Wisconsin. This early plant was only antedated by days by one other plant, the world's first steam-electric lighting plant at Pearl Street in New York City. These two pioneer plants share historical interest and commencing with their inaugural, the growth of the industry in Wisconsin has been in step with its national growth.

The Wisconsin survey had its inception about two years ago when the Wisconsin Public Service Commission, so intimately familiar with the power systems of the State for more than 30 years, enlisted the aid of Wisconsin utilities in gathering the data that would be of most value in such a survey. In November of last year the utilities completed a report on this survey and submitted it to the State Commission. The Federal Power Commission gave the State Commission credit for this study in its annual report for 1937 by stating under the heading of "Studies in Cooperation with State Commissions" as follows: "A study which was initiated by the Public Service Commission of Wisconsin involves a thorough and comprehensive investigation and survey of the developed and undeveloped power resources of that State, the existing and probable future markets for electric energy, the interconnections that may prove to be desirable and where the new generating facilities should be located."

In the survey the generating capacity studied was limited to include only steam and hydro plants with ratings of 1000 kw or more and internal combustion engine plants with ratings of 250 kw or more. This capacity was about 922,000 kw, representing slightly more than 97 per cent of the total capacity of all plants irrespective of size.

The first result of the study was the

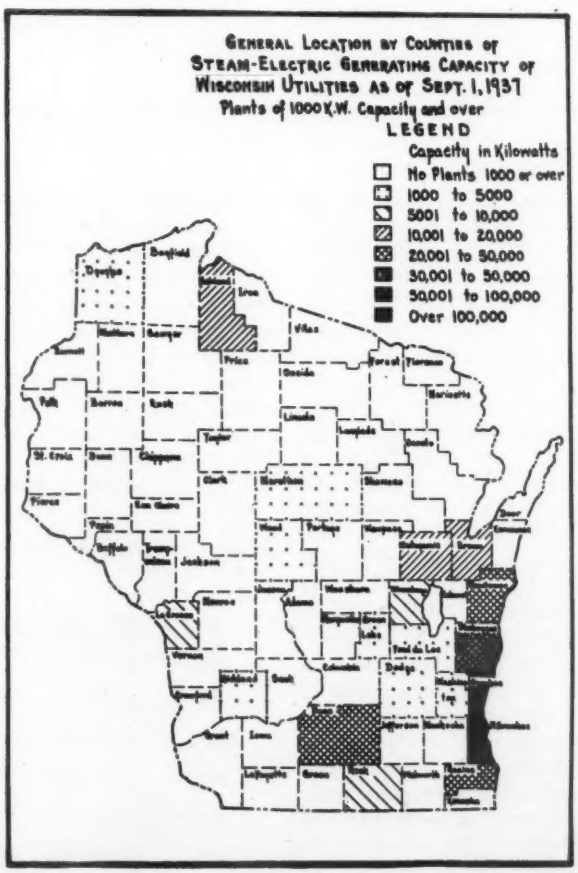


Fig. 1

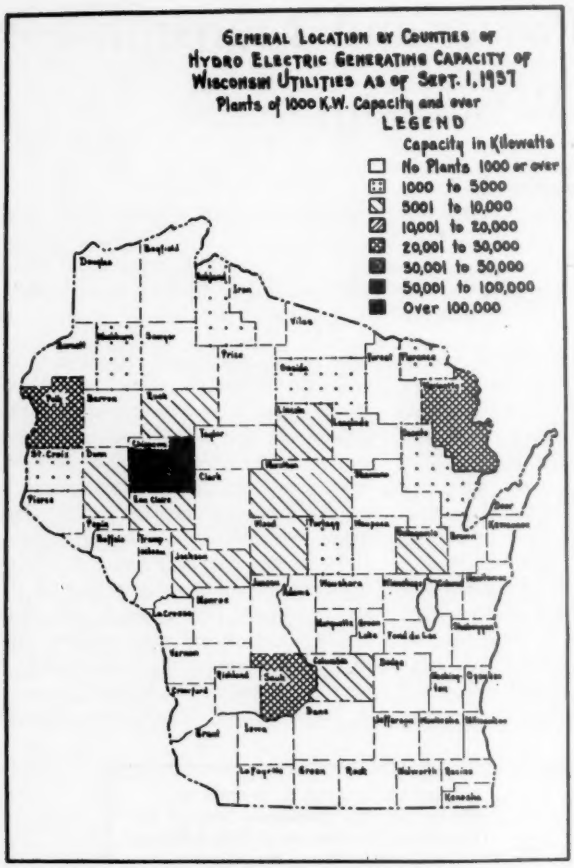


Fig. 2

General Location by Counties of
Internal Combustion Electric Generating Capacity
of Wisconsin Utilities as of Sept. 1, 1937
Plants of 250 K.W. Capacity and over
LEGEND
Capacity in Kilowatts
No Plants 250 or over
250 to 500
501 to 1000
1001 to 2000
Over 2000

Fig. 3

relative importance of the three sources of power supply, namely, steam, hydro and internal combustion engine, electric generation. Fig. 1 shows the steam-electric capacity, of about 670,000 kw, by counties in Wisconsin. It indicates that the steam plant capacity is concentrated along Lake Michigan in the southeastern part of the state. Almost 4/5 of the steam plant capacity of the state is located in this area. Because of the large amount of condensing or cooling water required by steam plants (700 to 900 tons for each ton of coal burned), these plants are usually located on the shores of large lakes or on the banks of rivers. Lake Michigan supplies the cooling water for six of the largest steam plants of the state. Coal may be supplied in this district by lake shipments as well as by rail lines, and it is cheapest at the lake ports. The farther inland from these lake ports, the higher the cost of coal becomes. The steam plant is the most efficient source of power production in the state. The record of the Port Washington plant shows that for an entire year it produced energy at the average rate of 10,835 Btu per kwhr of net output and for an entire month at 10,590 Btu per such unit output. On the basis of the average heating value of coal consumed in that month this economy record was equal to 82/100 of a lb of coal per kwhr.

Next to steam-electric output, hydro-electric output is the most important source of power supply in Wisconsin. The state is not rich in water power, either developed or undeveloped. It is not located so that its streams are fed by large natural reservoirs, mountain snows or large drainage areas that contribute toward uniform stream flow. In the absence of such favorable conditions, the flow of the relatively small rivers of Wisconsin depends upon local rainfall or on subterranean overflow affected by rainfall. Stream-flow therefore varies widely with the amount of precipitation common to the seasons. This means wide variation in electric power output. Over

Table I.—Annual Output of Plants Operated by Wisconsin Utilities in Wisconsin and in Border Territory Outside of the State—Years 1931 to 1936 Inclusive

Year	Steam-Electric Thousand Kw-hr.	%	Hydro-Electric Thousand Kw-hr.	%	Internal Combustion Engine Thousand Kw-hr.	%	Total Output Thousand Kw-hr.
1931	1,193,852	58.8	829,715	40.7	11,146	0.5	2,034,713
1932	1,031,222	54.6	845,756	44.7	12,790	0.7	1,889,768
1933	1,099,695	59.2	745,590	40.0	15,409	0.8	1,860,694
1934	1,172,726	57.2	857,967	41.8	15,845	0.8	2,046,538
1935	1,189,985	48.9	1,229,579	50.5	15,801	0.6	2,435,365
1936	1,564,718	61.3	969,390	38.0	18,992	0.7	2,553,100

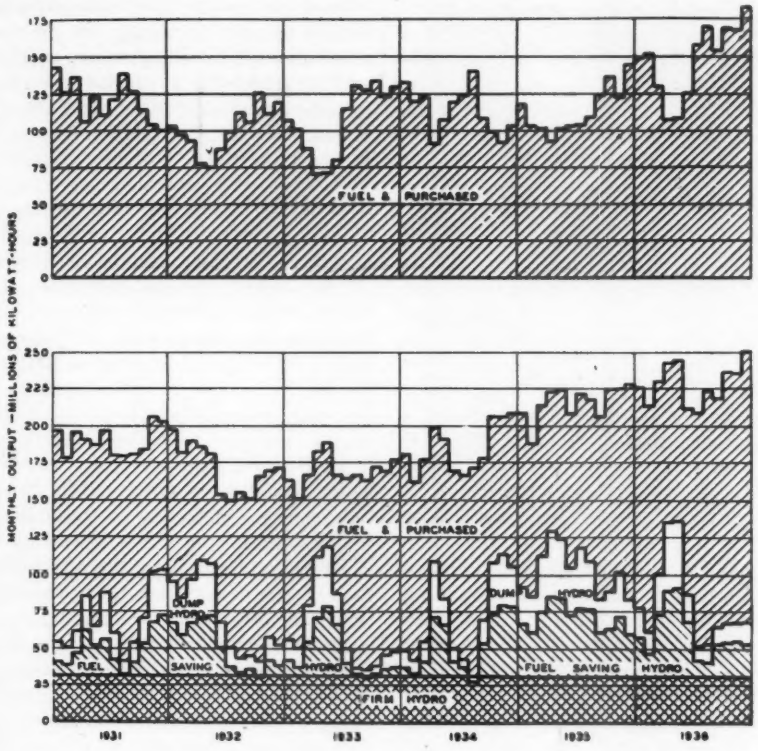


Fig. 4—Classification of Monthly Power Output of Wisconsin Electric Utilities

a 6-year period the output of all hydro-electric plants of the State has varied from 32,000,000 kwhr in August, 1934, to 136,000,000 kwhr in May, 1936. Standby capacity, provided by fuel-burning plants, is therefore required to firm up the hydro capacity.

Fig. 2 shows that the hydro-electric capacity of about 240,000 kw, is mostly located in the less densely populated areas of northern Wisconsin and on the Wisconsin River in central Wisconsin. The common center of hydro generating facilities of the state is approximately 95 miles from its center of population. The sites of hydro plants are fixed by nature and the larger cities are located elsewhere because of other factors, indicating that if hydro power is to be marketed in these cities long distance transmission of power is necessary. This may make the marketing of hydro-electric power under such conditions unattractive, because of the competition from steam-electric power produced at low cost.

Fig. 3 shows internal combustion engine electric capacity by counties of the State. It includes plants rated at 250 kw or over, representing total capacity of only 12,000 kw. In the western part of the State this class of capacity is used for local power supply and standby purposes, and in the eastern part of the State it is used by a few municipal utilities.

Associated with capacity is the output of the three classes of power supply. Table I shows that in 1936, 61.3 per cent of the total output was supplied by steam power, 38 per cent by hydro power and only .7 of 1 per cent by internal combustion engines. The percentages of hydro-electric output show variations which reflect water conditions in each year. Good water conditions were experienced in 1935 and hydro-electric output in that year was more than one-half of the total output. In 1934 when hydro-electric output was lower, it supplied less than 42 per cent of total output. In years of low-stream flow, steam-electric output has been greatest indicating that the steam plants have provided the reserve and standby capacity necessary to make up the deficiency in hydro-electric output. As the loads grow more of the required output will have to be supplied by steam plants.

Fig. 4 shows how the monthly power output varied over a six-year period in meeting the requirements of Wisconsin utilities. The area designated "Fuel & Purchased" is almost entirely steam-electric output including a little internal combustion engine output and purchased power. Hydro-electric output cannot be relied upon to meet its share of the requirements since its availability varies widely from year to year and with the seasons in each year. The bottom block of hydro output, continually available, is Firm Hydro and averages 41 per cent of total hydro output. The middle block of hydro output, is Fuel Saving and is made usable in the state by curtailing output of fuel burning plants. It averages 31 per cent of total hydro output. The top block of hydro output

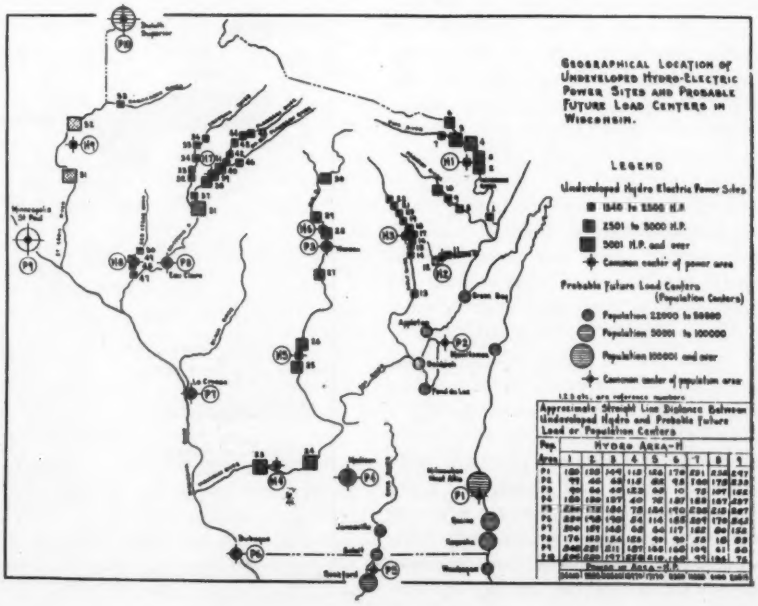

GEOGRAPHICAL LOCATION OF UNDEVELOPED HYDRO-ELECTRIC POWER SITES AND PROBABLE FUTURE LOAD CENTERS IN WISCONSIN.
LEGEND
Undeveloped Hydro Electric Power Sites
1540 to 2500 H.P.
2501 to 5000 H.P.
5001 H.P. and over
Common center of power area
Probable Future Load Centers (Population Centers)
Population 25000 to 50000
Population 50001 to 100000
Population 100001 and over
Common center of population area
Approximate Straight Line Distance Between Undeveloped Hydro and Probable Future Load or Population Centers
HYDRO AREA-H

Fig. 5

is surplus or dump power and averages 28 per cent of total hydro output. This surplus hydro is sold outside of the State. The output of fuel plants including a small amount of purchased power is shown separately, in the top part of the chart, to picture its true change from month to month. This class of output supplies the major part of the load and changes with requirements and with its use as standby to increase output from hydro plants when stream flow permits.

One of the next objectives of the study was the extent and importance of undeveloped water power. Fig. 5 presents the relative location of undeveloped hydro power sites and of population centers with probable markets. The circles including numbers preceded by the letter H represent centers of undeveloped hydro power, and the circles including numbers preceded by the letter P represent centers of population. The undeveloped hydro areas are generally far removed from the population centers such as the largest population centers in southeastern Wisconsin. Absence of local markets nearby undeveloped hydro power areas means that if the hydro power is developed long transmission lines will be necessary to transmit such power to the market. This introduces economic and technical factors which may prove to be unfavorable for hydro-electric development. With most of the best hydro sites developed for power generation it becomes increasingly difficult to justify additional hydro power in competition with steam power. Data in the Wisconsin survey show that the unit investment required for hydro-electric capacity may be from two to three times that of steam-electric capacity and this comparison is without making any charge to hydro for investment in fuel burning reserve required to firm up its output. Figures developed in the report, to cover production costs including fixed charges, show that in base load service steam-electric power can be supplied at about 4.4 mills per kilowatt-hour at the switchboard as compared with 6 mills per kilowatt-hour at the switchboard of the hydro plant. Hydro-electric plant efficiencies have advanced to better than 90 per cent. On the other hand, in spite of the advancement made in steam plants, the best thermal efficiency with the steam cycle is only about 32.5 per cent. Opportunities for further advancement in steam plant efficiency still exist.

The extent to which the transmission and substation facilities joining one utility system with another are being utilized in Wisconsin is shown in Fig. 6 which illustrates the flow of energy between Wisconsin utility systems in 1935. The flow lines on this chart are transfers of power between systems. Most of the power is transferred over relatively short distances and large transfers are confined to systems in southeastern and western Wisconsin. In the southeastern district the large blocks transferred are largely steam power and in the western district the flow from Wisconsin to Minnesota is hydro power consisting largely of surplus hydro not usable in Wisconsin. The thin arteries on the chart show how power flows from the larger systems to the smaller systems which in many instances are small municipal utilities. All transfer of energy in 1935 involved the use of 123 active interconnections between utility systems. In the case of 100 of these interconnections, the energy flowing through the point of interconnection was in one direction, constituting energy furnished entirely by one system to another. With these 100 interconnections an important objective of interconnection was realized; namely, that it resulted in the combining of loads to secure the benefit of large scale power production. In the case of the 23 other interconnections, energy was transferred in both directions, including the delivery of firm power by one system to another, and the interchange of surplus power and of emergency capacity. In 1935 the transfer of energy shown on this chart, involved the transfer of over 906,000,000 kwhr of electrical energy among Wisconsin utilities and with utilities in adjoining states. In that year the energy transferred in this manner amounted to 35 per cent of the toal power requirements of all Wisconsin utilities. This indicates that out of every 3 kwhr required by Wisconsin utilities in 1935, in serving their loads inside and outside of the state, more than one kwhr was transferred from one system to another.

In effecting power transfer between Wisconsin systems use is made of approximately 6,000 miles of transmission circuits operating at from 20,000 up to 132,000 volts, and more than 1,150,000 kv-a of transmission substation capacity. The report covers the technique of power transmission and transformation and its importance in considering interconnection. The great progress already made in this field shows that interconnection is not a new subject. The power supply system of this nation ranks sec-

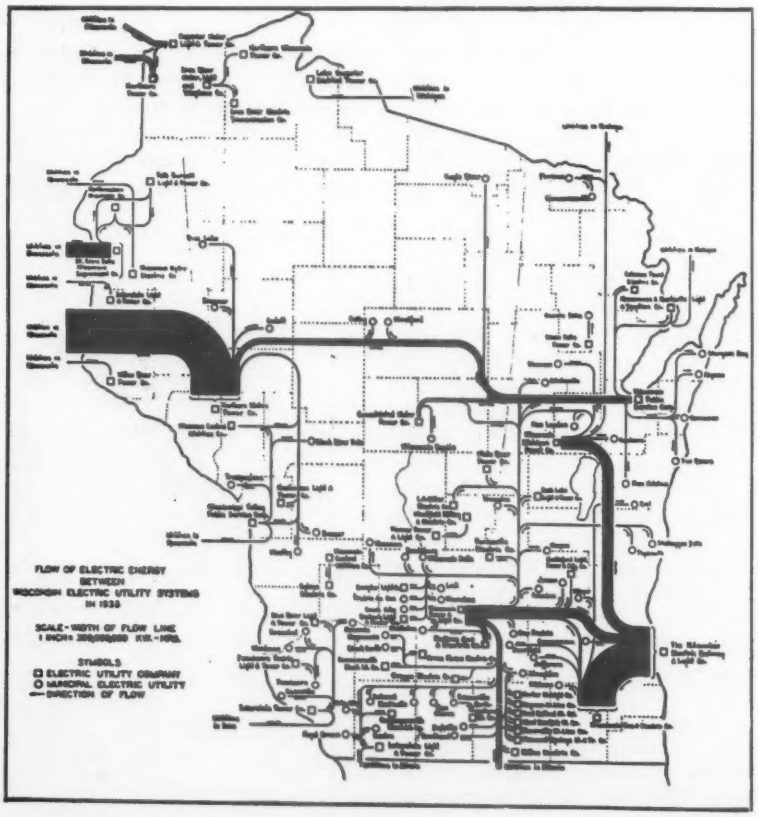


Fig. 6

ond to none. Records show that a committee appointed by the Board of Trade of the British Government, to promote what is known today as the British Grid System under the provisions of the British Electric Supply Act of 1926, obtained advice from those experienced in the development of the power supply in the United States as how best to proceed with interconnection in England. After consulting various American authorities on the subject, this committee stated in its report "we find that in America the great supply systems have developed the business of selling electricity into a very fine art, with the result that there has been a rapid increase in the consumption of electricity per head of population."

The Wisconsin report showed only 12 instances where additional interconnections might possibly be made. Recently two of these interconnections were found desirable and were made. The remaining 10 possibilities for interconnection are believed to be of questionable value at present. Some of them may become desirable as conditions change.

Time does not permit presentation of other results relating to the Wisconsin study. In addition to what has been shown the study also covers diversity between system loads, future power requirements, possibilities of extending existing generating facilities and additional generating capacity under construction.

In concluding, I wish to add a few general comments on interconnection and coordination.

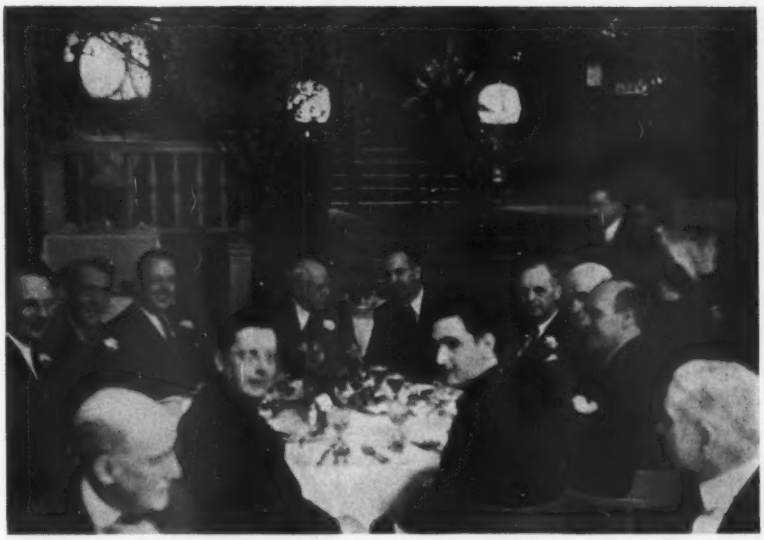
If greater efforts for more complete coordination of power facilities are extended, what should we expect from an interconnection?

A true interconnection between utility systems must embody the spirit of mutual assistance; i.e., each system which is a party to such interconnection must in times of emergency be willing to furnish capacity for the other system without restraint up to the limit of its ability to give such support. This should not be done merely for the sake of making interconnections nor should interconnections be permitted to jeopardize the interests of customers and investors. If the proposed connection is found to be sound from the viewpoint of both parties, it should follow that those who have a stake in the business will not have their interest unduly jeopardized.

An interconnection should also take advantage of diversity between system loads and should result in centralizing power generation at economic locations and in efficiently designed plants, reducing reserve capacity, staggering construction of additional capacity between different systems, utilizing generating facilities more efficiently and making capacity from one system available to another in case of an emergency.

More complete coordination of power facilities also involves the prospect of additional regulation.

The Wisconsin study has verified a fact known to private utility management for many years; namely, that if the advantages and economies resulting from linking electric facilities are to be effective, interconnection cannot be confined to political boundaries and must be regional in scope. Private utility management itself originated regional development by controlling and operating power facilities extending over large sections and over state lines. This coordination of power facilities was directed to make efficient and reliable service at reasonable cost available to the users of electrical energy in the region. Under a strong trend for more governmental supervision over business and especially the electric utility business, this development, outstanding for its economic and technical achievements, received more than its share of additional regulation.



A Luncheon Group at the E.E.I. Engineering Meetings

T. & D. Committee Meeting

(*Continued from page* 224)

Test on Ozone Resisting Rubber Insulated Cable for Underground Installations, by C. T. Hatcher.

Progress Report on the Study of Heat Dissipation from Transformer Manholes and Vaults, by L. A. Nettleton.

Pre-insulated Crab Joint for Splicing Out 4000 Volts, Non-Leaded Cable, by C. N. Metcalf and E. G. Schairer.

Progress Report — Physiological Lamp Flicker Test on Short Duration Resistance Welded Dips, by Woodman Perine.

The latter part of the afternoon session was devoted to a round table discussion at which problems of current interest were discussed.

An interesting feature of this series of meetings was the dinner meeting held on the evening of May 3 for those in attendance at the meetings of the various committees. Mr. H. W. Eales presided as Toastmaster. Addresses were given by Mr. C. W. Kellogg, President of the Edison Electric Institute, and Mr. L. F. Seybold of the Milwaukee Electric Railway & Light Company.

Water Heating Award to Be Made at Convention

THE period for submitting entries for the Award of the National Electric Water Heating Council to the utility achieving the most outstanding results in the promotion of electric water heating service for the calendar year 1937 closed on May 1, 1938.

The prize of $1,000 and a Silver Cup will be presented by Mr. H. P. Liversidge, Chairman of the Prize Awards Committee, Edison Electric Institute, during the Banquet, Wednesday evening, June 8, at the Convention in Atlantic City.

The Judges in the contest are Edgar Kobak, Lord & Thomas, Advertising Counsel; Henry Dooley, McGraw-Hill Publishing Company, and F. E. Watts, Electrical Publications, Inc.

Electrical Equipment Committee Meeting

J. F. Fairman, *Chairman*

THE spring meeting of the Electrical Equipment Committee was held in Chicago, Ill., May 2 and 3, in conjunction with the other engineering committees of the Institute. Twenty-eight members of the committee were present, and 31 visitors attended the open sessions of the committee.

Following the usual practice of the committee Monday morning was a closed session devoted to discussion of apparatus trouble reports and bushing troubles. In addition, Mr. Dean presented for review by the committee the Specifications for Oil Circuit Breakers, prepared by the AEIC Committee on Electric Switching and Switchgear in consultation with the Electrical Equipment Committee and representatives of the manufacturers. The final draft of this specification was completed only the week before, and as soon as approved by the AEIC Committee it will be published by them for use in connection with purchase of oil circuit breakers. It is hoped that the use of this standard form of inquiry and specification will simplify the purchase of breakers, both from the standpoint of the user and from the standpoint of the manufacturer.

The Meter and Services Subcommittee held its meeting in Chicago on Monday also, and the member of this subcommittee had an opportunity to attend certain sessions of the meeting of the main committee. The report of the subcommittee made by Mr. A. J. Allen, chairman, briefly reviewed the rapid development which has been made in meters over the period of the past twelve years, and recommended that the fruits of this development should now be capitalized and that further changes in meters should be severely restricted. This work has also included improved service connections and meter mounting with a reduction in the possibility for energy diversion. The committee has devoted a large amount of its recent effort to the revision of the meter handbook. At the present time it is expected that the new book will be available the latter part of 1939.

Papers giving the recent trend of development in large rotating machines were presented by D. M. Jones of the

MR. FAIRMAN

General Electric Company, C. M. Laffoon of the Westinghouse Electric and Manufacturing Company, and S. H. Mortensen of Allis-Chalmers Manufacturing Company. These papers pointed out more advanced design in the manufacture of large generators and synchronous condensers and the present trend of development in these fields.

Mr. Van Ness presented a progress report on Generator Insulator Testing. This report is printed in this issue of the BULLETIN. It supplements the report on this subject printed on Page 509 of the December, 1937 issue of the BULLETIN. Although the work to date has not found a solution to the problem of determining the condition of insulation of generators after they have been in service, considerable progress has been made and it is the hope of the sponsor that a solution will be found in the near future.

Under the sponsorship of Mr. Wallau a questionnaire on bus protection systems, prepared in cooperation with the Protective Devices Committee of the AIEE, was sent to all members of the committee. To date 26 companies have reported a total of 930 bus protection systems installed and 89 proposed installations. There is a preponderance of differential protection with 701 installations. The replies to the questionnaire listed 179 installations of fault bus and 117 installations of partial differential protection. In addition there were 20 installations which were a modification or combination of these.

Mr. H. C. Forbes presented a brief paper supplementing his paper presented last February on Generating System Capacity Reserves. The additional work accomplished is based on an analysis of reports of the Prime Movers Committee and the Hydraulic Power Committee, giving the availability of generating units over a period of a number of years.

Mr. Philip Sporn presented a paper showing the fundamental system planning of the American Gas and Electric Company. This paper pointed out the layouts of the original systems which were consolidated into one large system, and showed how the plans had been developed, both to take care of immediate conditions and future additions to the system. He pointed out how a fundamental plan should be made to cover developments for many years in the future, although plans for actual additions should be made only at the time that the additions were to be made.

Mr. H. S. Fitch presented a revised draft of the report on Rehabilitation of Flood Damaged Equipment. This report is now receiving its final review and should be available for publication in the very near future.

Mr. Hentz stated that the serial report on Design of Switchhouses for Generating Stations and Transmission Substations had been completed and would shortly be available as a printed report of the committee.

The Tuesday afternoon session was joint with the Accident Prevention Committee and the Transmission and Distribution Committee. A brief summary of this joint session is included in the accompanying article by Mr. Seelye.

The symposium on Utilization Voltages, which was presented at this session, is printed in this issue of the Bulletin.

The next meeting of the committee will be held early in October.

Accident Prevention Committee Meeting

L. M. Shadgett, *Chairman*

THE Spring Meeting of the Accident Prevention Committee was held at the Edgewater Beach Hotel, Chicago, Illinois, May 2-3. This was a two-day meeting, the afternoon of the second day being devoted to a joint session with the Electrical Equipment and Transmission and Distribution Committees. There was a good attendance of committee members, and a number of visitors and guests attended and participated in the discussions. Following is a brief outline of some of the subjects discussed.

Statistics

Available statistics were quite disappointing. They showed that the accident record of the Electric Light and Power Industry had taken a distinct turn for the worse since 1935, whereas from 1924 through 1935 there had been a substantial and consistent decline in the number and severity of the accidents experienced. The record for the year 1936 was substantially worse than the 1935 record, while the available figures for 1937, although by no means complete, indicate that the 1937 record will be worse than the 1936 record, this trend being surprisingly uniform throughout practically every section of the country. This setback in the record is of course a matter of concern to the members of the Accident Prevention Committee, and should be to the industry generally, because the adverse trend since 1935 will undoubtedly continue to get worse unless checked.

A rough analysis of the figures indicates that men doing over-head line work have the worst record. It further indicates that most of the injuries are being sustained by comparatively new employees, that is, those of less than one year of service. Many of the most severe accidents are being sustained by older employees of many years experience, however.

Employee Training

Assuming that new employees are being selected with reasonable consideration being given to the work they are to do, the trend mentioned above obviously indicates the need for better training of employees. The Committee has therefore decided to place all possible emphasis on this matter, that is, on the need

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for training new employees to handle their jobs safely, and the need for closer and better supervision of these newer employees. Incidentally, it is evident that any systematic attempt to train newer employees will also benefit the more seasoned employees because they will naturally absorb a great deal of the information being given to the newer employees. Everyone of course realizes that any effort directed toward training employees to perform their work safely will undoubtedly have the effect of improving the efficiency and quality of their work.

In this connection, Mr. W. A. Buchanan, the Committee's immediate past chairman, gave the Committee a rough outline of the detailed training courses his Company is developing in response to the obvious need. These take the form of individual courses for the various grades and types of workmen, and after their preparation has progressed a little further this Committee hopes to be able to use them as a basis from which to draw up some condensed outlines of suggested courses, which outlines interested Operating Companies can elaborate on and adapt to suit their local conditions. This Committee wholeheartedly recommends to all Executives that each company take definite steps to improve this matter of employee training with the idea of giving the men a better opportunity to learn to do their work well, to do it safely, to take care of themselves from a health standpoint, and thereby to prolong their useful careers and increase their earning power.

Electric Fences

A large part of the time was devoted to the matter of electric fences, this matter being of particular interest to the industry at this time because many of these fences derive their energy from central station systems, and also because of the rapid rate at which electric fences are coming into general use.

Recognizing the fact that electric fences have such obvious economic advantages over conventional types of fences that their use is going to become more and more widespread, this Committee has been studying this subject and keeping abreast of its developments for a number of years with the object of trying to direct the application of electric fences into reasonably safe channels. This of course necessitates working in cooperation with other groups and committees. It is of course important to pay proper regard to the viewpoint of the users of electric fences, and with this idea in mind Prof. F. W. Duffee of the Department of Agricultural Engineering of the University of Wisconsin had been invited to meet with the Committee. Professor Duffee, incidentally, is Chairman of the Technical Subcommittee on Electric Fences under the National Electrical Safety Code. This Subcommittee, of which two of the members of the Accident Prevention Committee are also members, has already prepared tentative specifications for the design, construction, and installation of electric fences, which specifications, when completed, will be offered for consideration in the current revision of the National Electrical Safety Code.

It was evident from Professor Duffee's presentation and the resulting comments and suggestions that the divergent viewpoints of the interested parties are rapidly becoming reconciled, and that they are now working reasonably harmoniously together in an effort to see that proper safe-guards are placed around the applications of electric fences. The Accident Prevention Committee

will of course continue to take a very active interest in this matter.

Rubber Protective Equipment

Discussion was continued as to the practicability of raising the voltage level on which rubber gloves may be safely used under usual working conditions. Despite the improvements that have been made in rubber goods during the last few years, the limitations of present-day materials and methods of manufacture still make it advisable to recommend against the general use of rubber gloves on voltages higher than 3000 volts to ground unless supplemented by the use of other insulating materials somewhere in the possible paths to ground.

One member company who is a large user of rubber gloves and whose experience with the periodic testing of rubber gloves and the discarding of weakened gloves has been far from satisfactory, has been experimenting for some time with the use of high voltage direct current for testing purposes. While not yet conclusive, the present experience indicates that this direct current testing has some very advantageous features, and it is possible that further experience during the current year will indicate the desirability of using direct current tests as a criterion as to whether rubber gloves should be discarded or not.

Traffic Accidents

Studies made by the Subcommittee on Traffic Accidents during the last several years indicate that many drivers of company vehicles do not possess sufficiently good enough eyesight to be able to drive safely. This principle is already recognized by several States which now require visual tests as a requisite to the obtaining of a driver's license.

For several years now a number of member companies have been giving their employees, particularly those who drive automobiles, trucks, buses, or street cars, careful tests to see if they have reasonably good eyesight. Detail reports submitted by eight of these member companies scattered throughout the country, and covering tests to more than 8000 employees, show that approximately 30 per cent of those examined had vision which was sufficiently defective as to require immediate correction; that is, their normal vision was not good enough for them to be able to drive safely.

There are several practical methods of making these tests, using charts or simple devices which can be operated satisfactorily by a layman, the idea of course being that these tests will merely detect those whose eyes need attention or correction, thereby causing them to realize that they need to go to an eye doctor for a professional examination and prescription.

Based on experience to date, the Committee recommends that all member companies subject all drivers of Company equipment to these tests as a means of reducing the number of accidents sustained by or caused by drivers.

Principles of Hold-Off

Much discussion was had on the above subject, this discussion arising from the fact that some member companies still feel that their present methods of tagging out equipment or issuing clearances to workmen do not provide sufficient protection for the service or the equipment or the men. Inasmuch as it is primarily a matter of system operation, this subject was also discussed at the Tuesday afternoon joint session with the Electrical Equipment and Transmission and Distribution Committees. It was the consensus of those present at this joint session that it would be very desirable to have a written set of "Principles of Hold-Off" similar to the joint report on the "Principles of Grounding" (E.E.I. Pub. No. D9—October, 1936), and it was decided that a suitable joint subcommittee of the several main committees would collaborate and prepare such a set of "Principles of Hold-Off."

Economic Design of Overhead Primaries

(*Continued from page* 211)

It can be demonstrated that if these savings could actually be realized on every secondary as a result of such primary overbuilding, the loads per Table 1 could be economically decreased by about 25%. Practically, the savings can be realized on but few secondaries. In most areas where load density is less than 15 kv-a per thousand street feet—and this is the case in most areas fed overhead—the factor which limits secondary design is not steady-state regulation, but voltage dips due to motor-starting currents. On such secondaries, and on those whose peak is non-coincident with the peak load on the primary, potential savings are nil.

As a result of this investigation it was decided to make no adjustment of the values shown in Table 1 for economic loading, but a general rule was evolved that "the greater the proportion of the total drop taken in the secondary system, the greater the overall economy and the poorer the regulation."

Economic Improvement of Primary Voltage

Ordinarily the load density is less than "ideal," that is, a primary designed in accordance with the standards of Table 1 would give excessive voltage drop at peak load, and the most economic method of improving the drop must be discovered. Geographical distribution of the load, which unfortunately is infinitely variable, appears to be the determining factor, so that formulation of general instructions is not easy. By way of suggesting the alternatives which should be considered and to facilitate their cost comparison, a brief discussion of the several methods and devices available was included in the material distributed, together with charts and tables which might be useful in studying specific problems. The nature of this material is familiar and therefore is not reproduced here; it includes a set of curves showing voltage drop per ampere per thousand feet for various sizes and types of circuit, curves showing the effect of unbalanced loads on losses, derivation of simplified expressions for shunt capacitor applications, brief bibliographies, etc.

One of these curves illustrates a condition which may not be generally appreciated, and is reproduced here as a matter of interest (Figure 7). It shows the voltage drop on each phase of a two-phase three-wire extension from the three-phase main. Because of the different angular relation between the neutral current and that in each phase, unbalanced voltages may result from balanced loads; also a change in power factor affects the respective voltages in different degree.

Conclusion

The procedure developed by Public Service Electric and Gas Company for promoting economic design of overhead primaries has resulted in the production of what amounts to a brief textbook on the subject, as described herein; a more important result is the better use that is made of the engineering talent distributed throughout the several Divisions of the operating department.

Transmission and Distribution Committee Meeting

H. P. Seelye, *Chairman*

THE spring meeting of the Transmission and Distribution Committee was held at the Edgewater Beach Hotel in Chicago on May 3-4. This was during the group meetings of the engineering committees, all of which met at the same place during the week of May 2. The total registered attendance at this meeting was approximately 140, many of whom represented power companies in the middle west.

The first session consisted of a series of papers sponsored by the Transmission Group under Mr. Merrill DeMerit as Chairman. This included the following papers:

Simplified Transmission Line Planning, by A. C. Monteith, Westinghouse Elec. & Mfg. Co., E. Pittsburgh, Pa.

Design, Construction and Operation of a Lightning Proof Transmission Line, by Edwin Hannson, Pennsylvania Water & Power Co., Baltimore, Md.

Revamping a High Voltage Transmission Line for Increased Protection Against Lightning, by A. E. Silver, Ebasco Services Inc., New York, N. Y.

Ground Resistance Determinations in Connection with Counterpoise Installations, by Merrill DeMerit, West Penn Power Co., Pittsburgh, Pa.

The Counterpoise, by L. V. Bewley, General Electric Co., Pittsfield, Mass.

The presentation of these papers left little time for discussion and inasmuch as they were considered of timely interest, it was decided that they should be put into suitable form for publication as a committee report.

There was also presented during this session a report by Mr. D. M. Bunn of the Northern States Power Company on Expulsion Protective Gaps on Transmission Lines. This consisted of data collected for 1937 which had not been reported previously, and a three year summary covering the years 1935, 1936 and 1937.

The Plant Coordination Group, under the chairmanship of Mr. W. F. Davidson, had arranged for a demonstration of an instrument for the measurement of radio noise, which had been developed by the Tobe-Deutschmann Corporation in accordance with the specifications of the Joint Coordination Committee on Radio Reception of the E.E.I., NEMA and RMA (E.E.I. Publication No. C 9). This demonstration

MR. SEELYE

was presented by Mr. H. E. Kent of the Edison Electric Institute.

The afternoon session was held jointly with the Accident Prevention Committee and the Electrical Equipment Committee. During this session a symposium on System and Utilization Voltages was presented, consisting of a paper by Mr. H. P. Seelye of the Detroit Edison Company, followed by discussions by Messrs. Monteith, Ogden and MacNaughton. Papers were also presented by Mr. Harold Cole of the Detroit Edison Company on Distribution System Characteristics and Mr. Robert Morse of the American Gas & Electric Service Corporation on Specific Problems. The latter paper had been prepared by Mr. H. A. Enos who was unable to be present. It was decided that the papers presented in this symposium would be published in the Edison Electric Institute BULLETIN for May.

Mr. J. H. Foote described what, in his opinion, was the proper method of attacking the utilization voltage problem. He discussed the method that had been used in preparing the electric range specification and recommended that a somewhat similar method be followed in studying the problem of utilization voltages.

Mr. L. W. McCullough, Consolidated Edison Company of New York, Inc., presented a summary of data that had been collected bearing on Transformer Vault Fires and Explosions. This is material that had been obtained in a survey made by a special committee of the Electrical Committee, NFPA, in an effort to obtain information on which this subject might be studied in connection with the next revision of the National Electrical Code.

Mr. J. H. Foote presented the final report of the E.E.I.-NEMA Joint Committee on electric range engineering details. This included suggested standards of rating, performance and service facilities for domestic electric ranges which had been sent to members of the Transmission and Distribution Committee, Electrical Equipment Committee and Sales Committee under date of March 16, 1938. The suggested standard was approved and a recommendation adopted that the joint committee be disbanded.

A water heater test specification was presented by Mr. J. O'R. Coleman which included a report of the work that had been done in a joint committee to prepare test specifications for water heaters. This test specification was approved subject to minor modifications which might be necessary after further consideration. It was brought out in the discussion that this subject should not be considered as settled but that further study and experience are necessary before a final test specification can be adopted by the industry.

A progress report was presented by Messrs. H. S. Fitch, D. C. Stewart and Nicholas Stahl on Principles of Hold-Off. This is a subject which has been under consideration for several years by the Accident Prevention Committee, but which during recent months has been under consideration by a joint subcommittee on which are representatives of the Accident Prevention Committee, the Electrical Equipment Committee and the Transmission and Distribution Committee. It was brought out that the objective sought in this project is to develop sound principles of hold-off methods which may be used by individual companies in preparing safe practices for application by their respective companies.

The morning session on May 4 included papers and discussions sponsored

by the Underground Group and the Standards and Specifications Group. The Underground Group papers consisted of the following:

The Use of Power Factor Test Equipment for Indicating Defective Terminals of Network Transformers, by M. W. Ghen of the Duquesne Light Company at Pittsburgh.

Impulse Test on 24-27 Kv Three Shielded Conductor, Paper and Lead Cable, by G. B. McCabe of the Detroit Edison Co. at Detroit.

A New Semi-Underground Distribution System for Evansville, Indiana, by E. V. Sayles, Commonwealth & Southern Corp., Jackson.

During the last part of the session devoted to work of the Standards and Specifications Group, progress reports were presented on pole life records, line hardware and pin type insulator specifications.

The afternoon session on May 4 was a continuation of the session sponsored by the Standards and Specifications Group and contained discussions and talks on the various kinds of timbers, their characteristics and use. This subject was discussed by Messrs. T. R. C. Wilson and Arthur Koehler of the Forest Products Laboratory, Madison, Wisconsin, and several others who have encountered problems in the use of the various kinds of timbers employed in overhead power line structures.

This was followed by a paper on the "Economic Design of Overhead Primaries," presented by Mr. Paul H. Jeynes of the Public Service Electric & Gas Company, and was sponsored by the Distribution Group, Mr. W. F. Nimmo, Chairman. Considerable discussion followed the presentation of Mr. Jeynes' paper.

During the latter part of the afternoon, a closed round table discussion was held which was open to power company representatives only. This consisted of discussions on the progress being made in the revision of the National Electrical Safety Code, the lighting and marking of structures in the vicinity of airports and airways, transformer standards, standards for high voltage pin type insulators, and service drop cable.

The Subject Committee on Underground Methods and Accessories, Mr. J. A. Brooks, Chairman, of the Underground Group, held a meeting during the morning and afternoon of May 2. The following papers and reports were presented:

Gas in Manholes, by Roy L. Dodd.

Movement of Cable in Ducts, by A. Bodicky.

Preparation of Report—Cable Operation 1937, by E. R. Thomas.

(*Continued on page* 219)

Prime Movers Committee Meeting

W. E. Caldwell, *Chairman*

MR. CALDWELL

THE fourth Meeting of the Prime Movers Committee was held May 2-3 at the Edgewater Beach Hotel, Chicago.

Mr. H. N. Boetcher reported on the progress of work of the Special Metallurgical Committee. It is now well organized and is considering increasing the scope of its work to obtain data on creep in pipe. Mr. Boetcher also asked that arrangements be made to ascertain the opinion of the Committee on a specification for the purchase of boiler tubes free from mill scale.

Professor A. E. White discussed the probable causes for the wide variation in the physical properties of Carbon Molybdenum tubing and suggested an improved specification for purchase of that material.

Mr. P. W. Thompson reported that if the sale of a sufficient number of copies could be assured, the ASTM would publish a complete material specification on pipe, fittings, flanges, valves, etc., as requested by the Prime Movers Committee about a year ago. Indications were that there would be no difficulty in disposing of the required number.

The Chairman obtained a definite expression of opinion from the Committee that it would like to have the report of the Power Station Data Subcommittee continued and additional cuts issued to complete the present report.

The Secretary read to the Committee a letter from Mr. Reginald Fleming on the status of the Special Committee on Boiler Insurance.

Mr. J. R. Baker gave a résumé of the report of the Boiler Subcommittee, with special reference to the section on pipe welding, air heater corrosion, steam purification and boiler outage data.

Mr. W. H. Aldrich gave a statement relative to the contribution of the manufacturers to the Boiler Committee.

The Chairman recommended that Mr. Baker's report be sent to the Editing Committee upon completion, so that publication could be made as soon as possible. The Committee concurred in this recommendation.

In the absence of Mr. J. F. Muir the other members of the Combusion Subcommittee reported on the progress of its work. Others reporting were Mr. E. H. Tenney on Pulverized Fuel and Furnaces, Mr. J. M. Drabelle on Stokers, Mr. J. MacKenzie on Fly Ash Collecting Devices, Mr. D. C. Luce on Mechanical Draft Equipment and Mr. H. M. Cushing on Combustion Control. Mr. Caldwell asked to have the Combustion Report referred to the Editing Committee as soon as Mr. Muir has it assembled. Summary of the Oil and Gas Engine report was submitted by Mr. J. M. Drabelle, with the statement that all material would soon be ready for the Editing Committee.

Mr. C. H. Fellows stated that the Chemistry Subcommittee would not have a final report out this year, as sufficient time had not been available to complete the work before them. He was confident, however, that a very interesting report would be issued next year.

Mr. E. R. Crofts briefed the report of the Turbine Subcommittee and stated that all work was lined up for early completion and would be sent to the Editing Committee.

Detailed explanations were given by Messrs. Krieg and Mitsch on the recent troubles in the Logan Station and West End Station, respectively.

Among other subjects discussed at the Meeting, the following might be mentioned: Corrosion cracks in boiler drums and superheater headers, turbine blade troubles, air temperature control to pulverizers, electrical precipitators, reducing valves and boiler circulation troubles.

The Meeting adjourned at noon after which the members visited the high pressure installations at Fisk Street Station and State Line Generating Station.

Hydraulic Power Committee Meeting

E. B. Strowger, *Chairman*

THE Hydraulic Power Committee met on May 3 and 4 at the Edgewater Beach Hotel in Chicago. A number of subjects were considered during the sessions.

The subject of "Cost Data for Hydro-Electric Plants" developed a lively discussion. The bibliography appearing in the appendix, and a brief résumé of recent articles on the subject was presented by the Chairman.

It was concluded that the subject was a highly involved and complicated one in which an answer can be given only for specific cases. It is a question in which generalities are of little significance.

Mr. G. S. Diehl, in behalf of the Accident Prevention Committee, pointed out a recent up-trend of accident statistics in power plants, and the need of adequate training for the new men who have come into the organization with the shorter working hours.

Relation Between Flood Control and Power Development

The subject of Flood Control And Power Development was presented in a brief report by Mr. L. F. Harza, which was read by the Chairman.

Pumped Storage

One manufacturer reports that he has developed a reversible propeller turbine to be used as a pump in pump storage purposes involving relatively low heads. While no occasion has arisen as yet to require the practical use of this pump, several studies have been made for such use.

Another manufacturer has developed a pump-turbine unit of the Francis type.* Laboratory tests show that when pumping, a maximum efficiency of about 87 per cent was obtained on medium head units and that when generating, a maximum efficiency of about 88 per cent was obtained. The two speeds required may be met by the use of a two-speed type generator, the requirements of which have been studied by at least one electrical manufacturer who foresees no difficulty in building it.

* See "Hydro-Generation of Energy," by Frank H. Rogers, Proc. A.S.C.E., Dec., 1937.

MR. STROWGER

Problems of Dam Maintenance

Mr. Ray N. Benjamin of the Georgia Power Co. reviewed a report on dam maintenance, citing the experience with repair of concrete in the deck slab of a hollow dam. The dam in question has a flat reinforced concrete faced slab, inclined at an angle of 45° and supported by plain concrete buttresses. The spillway section is located in the middle of the dam and occupies 18 bays, which are housed by a reinforced concrete apron. The non-overflow sections consisting of 23 bays were not originally housed and developed disintegration of the deck slab. The dam is located in a northern latitude where the temperature ranges from a maximum of 85° F. to a minimum of minus 25° F.

A study of the portion of the slab affected revealed the presence of $CaCO_3$ deposits upon the surface and a condition of disintegration. The disintegration penetrated farthest at the center of the span, tapering to sound concrete at the seats. Local investigation has led to the theory that the disintegration is caused by the presence of water in the slab and by the action of frost upon the saturated concrete.

To protect the slab from frost the non-overflow section was housed by a timber bulkhead with insulation material added, and to repair the deck slab the defective concrete was removed and the concrete replaced by waterproofed mortar and by guniting. The work was done without unloading the slab, it being assumed that the concrete remaining together with the exposed reinforcing rods acted as a bow string arch, the stress in which could be calculated.

On this same subject of dam maintenance, Mr. Merriam pointed out that some types of repairs with Gunite should be used with caution on the downstream face of a gravity dam where there might be danger of forming a dam against seepage water that might have developed sufficient pressure to lift the concrete. He pointed out that there have been cases where the actual pressure gradient had been considerably above the gradient from upstream face to downstream toe of the dam and called attention to a plan used by a French engineer on dams needing additional protection against uplift. The plan uses steel cables anchored on one end to bedrock with full hold-down pressure developed by stressing the cable by jacks working against mushrooms attached to the ends of the cables. The mushrooms and jacks are finally concreted in place. He also called attention to one dam where reinforcement against uplift was provided by means of anchor rods threaded and stressed by means of nuts.

The details of the method of repair described above for the hollow dam are being studied by the Committee and also by Prof. McMillan of the Portland Cement Association, with a view of getting more specific information on the behavior of concrete and improvement of structural practice generally.

Drainage Under Dams

The subject of drainage systems under dams emphasized the wide variation in practice of engineers relative to the location of drains in and under dams. Trouble has been experienced in some instances where dirt and sediment or calcium carbonate deposits have stopped up many of the drains. The desirability of providing in the design means of exploring and keeping all drains open was brought out by Mr. LeFever. He pointed out that in one dam provision of weirs for collecting sediment before it could enter inaccessible section of the drains had been a big help in keeping

them open. Attention was directed to the care needed in locating the outlets of drains in the bucket below the spillways. Impact effects may actually develop several feet of pressure above the tailwater level and cause flooding of the inspection passages. In other cases sharp reductions of pressure may occur in the drains.

Cyclic Analysis of Stream Flow Records

A review of methods of cyclic analyses of flow records was presented by Mr. Merriam. He mentioned the work by Professor V. Frolou, Dr. Meinzer, Abram Strieff and others. Attention was called to the danger of mathematical analysis emphasizing certain cyclic variations. The final graph may show cycles that are the result of the method of integration rather than the result of regularly occurring climatic cycles. He pointed out that this danger may be eliminated by four integrations of the original data. A cyclic analysis of rainfall in one basin developed fairly consistent cycles subsequent to 1891 and made the analysis look promising. However, extending the records back to 1825 developed basic irregularities with a large and irregular dip in the cyclic curve centering about 1880. Mr. Merriam called attention to the recording of ocean water temperatures by Atlantic steamers. They are being taken to see if ocean temperature may have some bearing on sources of long range weather changes.

Report on (a) The Susquehanna Emergency Net and (b) Progress of Flood Waves Down the Susquehanna River

Discussion of the Susquehanna emergency net by Mr. Merriam on Wednesday morning, May 4, was of special interest. In the Susquehanna valley, amateur radio operators have developed a cooperative plan which will function effectively and provide data needed for forecasting in times of flood, especially if the flood results in crippling lines of communication. Drills are conducted every other Sunday. All of the operators meet on the air and transmit river stages, weather and rainfall reports progressively from upstream to downstream stations, finally to base stations at Baltimore. The drill takes seven or eight minutes. During this period amateur operators outside of the basin cooperate in keeping off the frequency used on the emergency net. Four recordings of the conversations over the air in code were reproduced at the meeting. For the purpose of the recording the reports were later decoded. It is an unusual and rather thrilling example of people unselfishly drilling for the sole purpose of being of service to others in emergencies.

In mentioning recent plans of the Weather Bureau for establishment of additional rainfall stations in the Susquehanna and other basins, a novel plan for keeping a gage clear of silt was noted. A small high pressure tank is installed in the gage house and connected to the intake pipe through a valve. When it is desired to flush the pipe eight or ten pounds of dry ice is put in the tank and when sufficient pressure develops the valve is opened. The silt and water is readily blown out of the intake pipe.

Mr. Merriam showed a short film of an animated diagram map showing the progress of flood waves down the Susquehanna River. The film was based upon a very complete compilation of flood data published by the State of Pennsylvania. By working on stage relation curves it is expected that data from up-river may be interpreted in terms of what might be expected downriver at Holtwood.

Model Tests of Hydraulic Structures

Attention was called to the report on model tests of hydraulic structures completed about three years ago by a subcommittee of which Mr. S. O. Schamberger was chairman. The report contains many figures and photographs of test material and would be rather expensive to publish. It has recently been reviewed by Professor C. M. Allen of the Worcester Polytechnic Institute and Mr. H. N. Eaton, Chief of the Hydraulic Laboratory Section of the National Bureau of Standards. They have found that the report has many useful facts and suggestions and that it should be given sufficient publicity to bring it to the attention of persons who might be interested. The tabulation below shows the material covered by the report.

In case any Institute member wishes to use the report, it is available for loan from the Chairman of the Hydraulic Power Committee.

A recent publication of interest in connection with model testing work is entitled "Representative Hydraulic Laboratories in the United States and Canada," by Mr. L. J. Hooper, published by the Boston Society of Civil Engineers in connection with their January, 1938, Journal.

Mr. H. N. Eaton, Director of the National Hydraulic Laboratory, sent the Committee several copies of Bulletin VI of the National Bureau of Standards on "Current Hydraulic Laboratory Research in the United States." This publication sets forth a list of laboratories in the United States together with the model tests and research work which have been recently carried out or are now in progress.

Automatic and Semi-Automatic Hydro-Electric Stations

Mr. E. L. Peterson gave a report on the subject of automatic and semi-automatic hydro-electric plants. He described the Eastman Falls plant of the Public Service Company of New Hampshire and the Cataract Development of the Cumberland County Power & Light

No. and Date	*Structure*	*Purpose of Experiments*
1 — 1926	Chelan Spillway	To determine the best crest shape and apron protection for sand and gravel foundations.
2 — 1928	Martin Dam Spillway	To determine the spillway profile and pier shape for maximum discharge.
3 — 1926-29	Bell-mouth Intake	To determine the relative loss of head for a conduit having different amounts of flare at the entrance.
4 — 1931	Stark Intake	To determine most economical design for shallow pipe line intake.
5 — 1929	Spier Falls	To determine the economical design of forebay, intakes and penstock.
6 — 1928	Back River Tailwater	To determine the increased capacity due to discharging water directly from forebay to draft tube.
7 — 1930	Alder Creek 7½ in. Butterfly Valve	To determine operating characteristics of Barford type discharge valve.
8 — 1930	Back River Spillway	To determine remedy for erosion below sluice waves.
9 — 1932	Stop Log Dam	To determine remedy for erosion below dam consisting of piers and stop logs.

Company at Saco, Maine, from a brief description sent to the Committee by Mr. Frank Mason, Chief Engineer of the Nepsco Services, Inc. Each plant has a single turbine of the Kaplan type installed. The Cataract plant is of special interest because of the installation of gate limit control from tailwater in addition to gate limit control from headwater. The tailwater device is said to eliminate the necessity of excessive excavation for the draft tube, which would have been required had the unit been set low enough to avoid cavitation at low water and full gate opening.

A description of the arrangement employed at the Eastman Falls and Cataract plants in adjusting the blade angle of the Kaplan turbine during initial gate opening travel was presented from a letter from Mr. W. A. Bagley of the Engineering Department of the General Electric Company. It was pointed out that in an automatic hydro station it is desirable that the waterwheel start at a smaller gate opening than required to obtain synchronous speed. To accomplish this, in the majority of cases where adjustable blade wheels have been used, it is necessary to open the blade to an angle greater than that called for by the correct relationship between the blade and the wicket gate. For instance, at Eastman Falls it requires from five to seven gate openings to start the unit with the blades in the sixth degree position, whereas for no-load synchronous speed it requires approximately .12 gate opening. With the blades adjusted to the 19 degree position, the unit starts at approximately .14 gate opening and with this blade angle it requires approximately .24 gate opening for synchronous speed. To adjust the blades from the sixth degree to the 19 degree position during the initial gate opening a small oil pressure operated hydraulic lifting device was mounted directly on the main control cam-actuated oil valve that controls the flow of oil to the servomotor in the waterwheel shaft that actuates the blade. This device is in effect a small power cylinder with a piston and stuffing box. Oil is admitted on either side of the piston by a small four-way solenoid operated valve.

Mr. Peterson presented a paper entitled "Float Control Operation of Marmet Plant." A description of this plant was printed in *Power Plant Engineering* under date of February, 1937. Restrictions placed upon the Marmet Plant by navigation requirements require it to be operated with close restriction of the head-water elevation.

The float control at Marmet is unique in the fact that three large units (approximately 7000 hp. each) are controlled by a change in water level of only three inches. The starting, stopping, and loading of the machines are accomplished by operating the gate limit control of the governors by means of a float device. This device consists essentially of a Selsyn transmitter attached to the head-water float and three Selsyn receivers, one for each governor, so arranged as to operate the gate limit device on the governor. The result is that the gate limit device assumes a position at all times corresponding to the position of the float and hence to the head-water elevation.

The actual starting and stopping of the units is accomplished by means of contacts attached to the gate limit device of each governor, fixed to correspond to a pre-determined head-water elevation. Under a hypothetical example of operation and setting, let us assume that all units are shut down. A rising head-water will start one selected unit, put it on the line, and load it at approximately 50 per cent gate opening. If the pond level continues to rise, the first unit will continue to load up until reaching approximately 70 per cent gate, at which point a second selected unit will be started, put on the line, and loaded up to approximately 70 per cent gate. If the pond elevation remains constant, these two units will operate at 70 per cent gate. If the elevation decreases, the units will unload correspondingly until at a pre-selected setting; the second unit will be taken off the line.

The starting of the third unit is accomplished in a similar manner to that for the second unit, except that the first two units will have been loaded to approximately 80 per cent gate before the contacts close to bring on the third unit. If the pond level continues to rise, all three units will load to the full open gate position. As the head-water level decreases, the No. 3 and No. 2 units will go off in a manner similar to that previously described for No. 2 unit. If the level continues to decrease, the No. 1 unit will shut down at approximately 15 per cent load.

In order to avoid frequent shutting down and placing of units in operation due to possible intermittent fluctuation of the water level, a time delay is interposed in the sequence of operation.

With regard to the operation of the station, there is no operating personnel at the plant. Regular inspection and maintenance of equipment is performed by one man working 40 hours per week. All station records are received and recorded over the supervisory control system at the Cabin Creek Steam Plant, located 7½ miles from Marmet.

A paper on "Semi-Automatic Control for Hydro-Electric Stations" was received by the Committee from Mr. L. M. Moore of the Central New York Power Corporation and was briefly abstracted by the Chairman. This paper

(*Continued on page* 245)

APPENDIX

Some Recent Articles on Economics of Power Generation

Engineering Criteria of Economical Power Supply, Gordon Fox, *Jour. West. Soc. Engrs.*, Vol. 41, No. 3, June, 1936.

The Unified Development of the Tennessee System, A. E. Morgan, *Jour. West. Soc. Engrs.*, Vol. 41, No. 3, June, 1936.

The Nation's Power Supply: Its Economic Development Under Private Enterprise, Frank F. Fowle, *Jour. West. Soc. Engrs.*, Vol. 41, No. 3, June, 1936.

The Coordination of Hydro and Steam Power, H. G. Roby, *Jour. West. Soc. Engrs.*, Vol. 41, No. 3, June, 1936.

Hydro versus Steam Power, L. F. Harza, *Jour. West. Soc. Engrs.*, Vol. 41, No. 3, June, 1936.

An Outside Engineer's View of T.V.A. Development, George W. Hamilton, *Jour. West. Soc. Engrs.*, Vol. 41, No. 3, June, 1936.

Government Hydro versus Private Steam Power, Power Authority of the State of N. Y., House Doc. No. 52, 75th Congress, 2nd Session.

Progress in the Generation of Energy by Heat Engines, Geo. A. Orrok, *Proc. A.S.C.E.*, Dec., 1937.

Hydro-Generation of Energy, Frank H. Rogers, *Proc. A.S.C.E.*, Dec., 1937.

Improvements in the Utilization of Energy, Joel D. Justin, *Proc. A.S.C.E.*, Dec., 1937.

Cost of Generation of Electric Energy, Philip Sporn, *Proc. A.S.C.E.*, Dec., 1937.

Social Implications of Technological Trends in the Power Industry, Ralph A. Freeman, *Proc. A.S.C.E.*, Dec., 1937.

Electric Power in Economic Perspective, B. A. Thresher, *Proc. A.S.C.E.*, Dec., 1937.

Influence of Public Opinion, Daniel W. Mead, *Proc. A.S.C.E.*, Feb., 1938.

Hazards of Uneconomical Construction, Henry E. Riggs, *Proc. A.S.C.E.*, Feb., 1938.

An Appeal to Reason, William J. Wilgus, *Proc. A.S.C.E.*, Feb., 1938.

If Subsidy for Hydro, Why Not For Steam, Frank F. Fowle, *Elec. World*, Mar. 12, 1938.

Element of Cost, John C. Page, *Proc. A.S.C.E.*, April, 1938.

Heat-Generated Energy, C. F. Hirschfeld and R. M. Van Duzer, *Proc. A.S.C.E.*, April, 1938.

Hydro-Generated Energy, H. K. Barrows, *Proc. A.S.C.E.*, April, 1938.

Combined Energy Generation, Ezra B. Whitman, *Proc. A.S.C.E.*, April, 1938.

Minimum Standards for Medicine in Industry

By J. J. Wittmer, M.D.

Director of Personnel Department, Consolidated Edison Company of New York

and

Hart E. Fisher, M.D.

Chief Surgeon, Public Service Company of Northern Illinois

DETERMINATION of the minimum requirements for a medical service depends largely on what one hopes to accomplish through its inauguration. It may include pre-employment examination, treatment of industrial injuries and occupational diseases, reduction of absenteeism, preventive medicine through the supervision of plant hygiene and medical safety problems, first aid provisions or a general medical service to include, in addition to the preceding items, treatment of employees' minor non-industrial illnesses.

Very careful and thorough consideration should be given any plan submitted. Examples of unsatisfactory results have indicated that a medical service does not thrive on a trial and error basis of organization. It may be of interest at this point to note that the American College of Surgeons after exhaustive study in cooperation with representatives of industries and insurance carriers have adopted the following "Minimum Standards for Medical Service in Industry":

"1. The industrial establishment shall have an organized Medical Department or Service with competent medical staff including consultants; and also shall have adequate emergency, dispensary and hospital facilities and personnel to assure efficient care of the ill and injured.

"2. Membership on the medical staff shall be restricted to physicians and surgeons who are (a) graduates from an acceptable medical school, with a degree of Doctor of Medicine, in good standing and licensed to practice in their respective States or Provinces; (b) competent in the field of industrial medicine and traumatic surgery; (c) worthy in character and in matters of professional ethics; in the latter connection the practice of the division of fees, under any guise whatsoever, shall be prohibited.

"3. There shall be a system of accurate and complete records filed in an accessible manner, such records to include particularly a report of injury or illness, description of physical findings, treatment, estimated period of disability, and results, as well as other information pertinent to the case or required by Statute for Workmen's Compensation claims or other purposes.

"4. Patients requiring hospitalization shall be sent to institutions approved by the American College of Surgeons.

"5. The Medical Department or Service shall have general supervision over the sanitation of the plant and the health of all employees."

Companies having up to 300 employees working in one plant or within a limited district usually do not have their own medical office and facilities, but use instead the services of a local physician whose examination and treatments are given in his private office except in the case of an emergency when the physician is called into the plant to render treatment. This physician may also be used to examine applicants for employment in an endeavor to reduce industrial accidents by the elimination of physical safety hazards.

A recent development which has in the majority of cases proved successful has been the inauguration of a group medical service. A Medical Bureau is set up in a centrally located plant to care for the employees of several small plants industrially unrelated, but all in the same general locale. This innovation has resulted in an increase of medical facilities available and a lower employee per capita cost than possible had each of the plants set up their own medical service. This plan which has much to its credit is not to be mistaken for some of the commercialized medical offices set up in stores and lofts in factory districts, whose methods have been subjected to severe criticism and even to legislative action to eliminate them.

Companies having 300 to 500 female employees or the same number of employees predominantly female, should employ a full-time hospital trained registered nurse working in the plant and visiting sick employees at home in addition to the services of the physician giving treatments in his own office.

Beginning with companies or plants having more than 500 employees the ratio of physicians working in their own offices and available for emergency calls to the plants decreases and the number of physicians employed part time increases. This is found to be particularly true in public utility and electric equipment concerns whose record of providing medical service is very favorable when compared with all other types of industries.

When there are 1000 employees, up-to-date practices make it almost obligatory to have a part-time physician and at least one full-time male or female nurse according to individual plant conditions. In the groups above 1500 employees, the services of a full-time physician is practical and their number increases proportionately with the number of employees.

In organizations having more than 10,000 employees the procedure is to employ a group of full-time physicians who are assisted by a larger group of part-time physicians. This results from the fact that the larger the number of employees, the more likelihood that these employees may not be grouped in one central location, but in several locations within a city or within one particular section of a State.

In conclusion the question of the desirability of having a medical service has not been touched. It is assumed that this desire exists, not only as an effort to reduce the cost of industrial accidents but a sincere wish to assist the employees to maintain their good health under hygienic working conditions.

This is the sixth of a series of articles on Medical Service in Industry, prepared by the Subcommittee on Health, of the Accident Prevention Committee, E.E.I., composed of: Dr. Hart E. Fisher, Chicago; Dr. Noel G. Monroe, Boston; Dr. J. J. Wittmer, New York City; Professor Morris S. Viteles, Philadelphia and Wills Maclachlan, Toronto, Ont., Chairman.

The Subcommittee will welcome comments and discussion of these articles. These comments should be addressed to the

SUBCOMMITTEE ON HEALTH
Edison Electric Institute
420 Lexington Ave., New York, N. Y.

The Bondholder's Interest in the Equity

By C. W. Kellogg

President, Edison Electric Institute

A talk before the Insurance Division of American Management Association, Atlantic City, N. J., May 9, 1938

IT is interesting and significant that the Insurance Division of your organization should have expressed a desire to hear about the electric utility industry, since it shows up one of the important ramifications common to both insurance and the utilities.

Looking back over the history of both of our great enterprises, I think the rise of the investment standing of electric utility securities as a basis for the savings of the American people stands out as one of the striking developments of the last quarter of a century. The reasons for this investor confidence are not far to seek and can be simply stated.

You are of course primarily interested in the bonds of our operating companies. These have been kept down in amount to less than 50% of the property investment that secures them, thus giving an ample basis of protection to the bondholder. The further fact that this favorable debt ratio has been maintained in the face of an average growth in gross earnings which has doubled every eight years for the thirty years ending 1937—a period thus including even the recent great depression from 1929 to 1937—proves that the electric industry has been able also to raise vast sums through the years from equity financing.

I should like to elaborate the statement just made, since it forms the basis for my brief remarks on the electric utility industry.

While it is true that investment-wise you are primarily interested in the bonds of our operating properties, that does not mean that you are not also deeply interested in the equity investment in them. This interest on your part in our stocks depends not only upon the obvious fact that it is largely the cushion provided by the equity investment that makes your bonds a sound and safe investment; it depends also upon the ability of the companies to continue to raise equity money in large amounts in the future. For ours is anything but a static business. As just stated, gross earnings of the electric utilities averaged to double every eight years for the period of 30 years ending in 1937, and even in the decade just ended, which included the great depression, the gain in gross earnings was about 35%.

Bearing in mind that every dollar of new gross earnings requires an investment of $5.60 in additional plant to produce them, it follows that the present and past conservative ratio of bonds to property value could not long be maintained if ample construction funds were not available through the equity route. So that with the continual growth of the business your inherent interest in the equity part of electric utility capitalization is not only keen but continuing.

It may surprse some of you to learn that the hero in this drama of the financing of this rapidly growing business in such a manner as to keep the senior securities of its operating companies sound, is none other than the much criticised and belabored holding company. This heroic role follows inevitably from the overall results that have been shown plus the fact that 60% of the industry is controlled by these same holding companies. In the great six-year expansion period ending with 1930, during which about 40% of the present capital in the electric utilities was raised, the dozen largest holding companies, through the sale of their own securities or the application of their own earnings, contributed a full one-third of the capital requirements of the properties they controlled—an equity base which alone made possible the raising of the balance of funds required on a basis which at the same time maintained the conservative ratio of debt to property on which you rely for the soundness of the investment of your policyholders' funds. 1930 is after all getting to be eight years ago and you are naturally interested to know how the job has been done in the meantime and how it is being done today. During the depression years, 1931 to 1935, both inclusive, the capital requirements of the electric utilities were relatively small, consistent with the comparatively slight growth in earnings, so that during those years the cash obtainable from accruals to retirement reserves was more than enough to pay for the construction requirements of the utilities. Such a source of investment funds fulfills, from your viewpoint as bondholders, the same function as that raised by the sale of common stocks, in that a substantial amount of new plant is thus paid for without selling more bonds.

In 1936 and 1937, with business growth more vigorous than during the depression years, retirement reserve accruals were not sufficient to pay for all the plant extensions made; and while some cash was raised through the sale of bonds, still more had to be provided by withholding from the stockholders earnings which they should have been entitled to receive as dividends or from the sale of treasury assets. Some figures I have recently compiled, which aggregate the major part of the industry and are therefore fairly representative, show the following sources of construction funds for those two years, 1936 and 1937, in per cent of total:

Bonds	16.8%
Bank Loans	4.7%
Total Debt	21.5%
Stocks, a *decrease* of	1.0%
Sale of Treasury Assets or Reduction in Cash	6.6%
Undistributed Net Earnings	16.0%
Retirement Reserves	56.9%
	100.0%

Combining the last two items in the foregoing table shows a total of about 73% of construction funds during the last two years to have been raised from retirement reserves and undistributed net. This compares with only 26% of the total from these sources in the years 1925 to 1930, both inclusive. The substantial amount raised from sale of treasury assets and reduction in cash is, of course, non-recurrent.

It should be observed that the net increase in bonds in the last two years has

been comparatively trifling, as indeed it has since 1930, and that therefore the ratio of bonds to property value is even lower today than it was eight years ago. It must also be noted that the injury to utility equity credit due to government attacks on the industry has required the withholding from stockholders of properly earned net in order to apply the funds so withheld for construction purposes.

For the average industrial enterprise the development of plant largely, if not entirely, out of net earnings is both normal and healthy, but for the utilities it is both abnormal and unhealthy—abnormal because with our public regulatory system on the one hand and the relatively high capital requirements of the utilities on the other, these requirements must in general be raised by the sale of securities; unhealthy because the loss of equity credit rating indicated by the condition spells trouble for the future. The reason for this complete difference between industrials and utilities is inherent in the two kinds of business, the utilities requiring eight times as much capital investment per dollar of annual gross revenue as the average industrial enterprise. The effect on the utilities is injury to their credit due to fear of prospective stockholders to invest in an industry which either cannot pay out its net or, if it does, will be unable properly to care for the electric needs of the country, or both.

In case you may think I have exaggerated the situation respecting the utilities, or that what they are up against is more or less the same as everyone else engaged in business, let me give you a few figures to indicate what the utilities have done in the decade just ended. During this period the electric industry has raised and spent $4,621,000,000 on extensions to its properties. It has brought the blessings of electricity to 5,378,000 new customers. It has reduced the average rate per kilowatt hour in the home 35% and has done this in a period when the proportion of its gross earnings paid out in taxes has increased 70% and its labor cost per hour in the last five years has gone up 36%. It has done all this in the face of an attack by government as bitter and vindictive as it is unmerited in view of the fact that the purpose of government should be to help rather than to attack its citizens.

Of all the things government has done to the utilities one of the most flagrant is the so-called "yard-stick" alleged to be furnished by government hydroelectric plants. The theory put forward is that the result of the operation of government plants should serve as a yard-stick to measure the fairness of the rates charged by the privately-owned utilities. All of the so-called yard-stick plants are water powers. Average costs of four typical water power plants built on navigable streams by private capital show that about 92% of the total cost of their output consists of the fixed charges on the investment. In the case of the privately-owned plants this means the whole investment, since each of the companies had to raise all of the money to pay for the construction of the plant, including locks, fishways and all other appurtenances.

When the Federal Government enters this field we find them charging against power only a small part of the total investment. With the Bonneville plant on the Columbia River we find the Federal Power Commission finding that only 22% of the initial total investment should be charged to power (F.P.C. Release No. 380, Feb. 9, 1938), the balance going to navigation, which is carried by the taxpayer. In the case of T.V.A., while the Authority has made no official finding (as required by the Act) on the allocation of cost between water power and other functions, yet testimony of a member of the Authority before the Appropriations Committee of the House (pp. 362, 382, 385 and 386, April 1937) gave a total recommended allocation of about 37½% of the estimated cost to water power. Even if these small allocations were not alone enough to completely discredit any yard-stick idea, it is further true that up to date the T.V.A. has not in its published annual reports charged one cent for interest and depreciation (the largest items of cost to a private operator), and in taxes only about a third as much per dollar of gross as private companies average to pay.

While, therefore, it may be debatable whether or not it is sound public policy to assess the general taxpayer to pay for subsidizing cheap electric power for one or more restricted sections of the country, it is not debatable that such a performance as above described by T.V.A. cannot be a fair yard-stick to measure what anyone else could or should do without such subsidy from the general taxpayer.

Incidentally it might be mentioned that if the T.V.A. charged itself with fixed charges at the rate estimated by itself in its 1936 testimony before the House Appropriations Committee, and even using the inadequate amount of costs allocated to electric power, the amount it received from the sale of energy in 1937 would be less than one-half the cost of production of the power sold.

A similar use of governmental power to compete unfairly with the electric utility business arises from the donations that have been made by the Federal Government of 45% of the cost of construction to any city desiring to compete with the local utility within its borders. In the case of a utility manufacturing power from coal and distributing it to individual users, fixed charges form five-eighths of the total cost of the service, thus making such a donation a serious attack on the utility.

Faced with this unfair and subsidized competition by the Federal Government, the question naturally arises why should the Insurance Companies continue to pay the highest prices of all time for electric utility bonds? I believe the answer lies in the fundamental soundness of the business and belief in the ultimate fairness of the people. May I restate the elements of this strength and how they have been again demonstrated during the great depression.

As a measure of how severe the depression was with general business, I will remind you that, on the basis of 1929 at 100, the bottom of the depression found the index of manufacturing production at 53 and of steel production at 23. In contrast to this the corresponding index of the gross earnings of the electric utilities at the bottom of the depression (1933) was 90.5. This stability was helped by the fact that 37 per cent of the gross of the electric business comes from the home and with respect to this part of its business the index was 104.5. Such stability as this in earnings in the face of constantly falling rates makes the bonds of operating electric utilities well-nigh invulnerable so far as earnings are concerned; but the same degree of invulnerability could not continue in the face of excessive issues of bonds, if such were forced in future on the electric utilities as they have been, to their ruination, on the steam railroads by inability to raise equity money in adequate amounts. This is merely repeating what I said earlier as to the essential vital interest which the bondholder has in the welfare of the stockholder—an interest often not fully appreciated in the past.

The second point of stability arises from the large proportion of the electric business which rests on a competitive basis. To those of you who have thought of the electric business as a monopoly my statement may sound paradoxical and somewhat disturbing, but upon further reflection I believe you will see that such is not the case. Analysis shows that about one-half the gross earnings and two-thirds of the energy sold depend upon competitive excellence with respect to any other way of getting the same service. This competition is with the gas-man, the ice-man and the private manufacturer of power. The beneficial effects are twofold:

In the first place there is a tendency to minimize the importance of franchises. In the early days of the electric utilities a franchise was considered an asset of transcendent importance, which led to trading with city councils that was unfortunate for all parties. Today a franchise is recognized as a mere permit to occupy the streets in order to carry service to the people; the only value it has is a nuisance value when it comes up for renewal, since rates and service are principally fixed by state commissions.

The second favorable result from the competitive nature of our business is the stimulation of the operating forces. Competition has been called the life of trade and the reason this is so is that it sharpens wits and stimulates effort toward improvement. The deadening effect of complete monopoly is nowhere more apparent than in government bureaucracies of all kinds, where lack of competition smothers all imagination and special effort at improvement. The electric utilities spend $60,000,000 a year on sales promotion and as much or more is expended by the manufacturers and distributors of electrical equipment.

The high standing of electric utility bonds with the insurance companies and other conservative investors is therefore soundly based on the steady growth and great stability of the utility's earnings, its ability to win in the competitive field and the policy that has been followed of keeping the amount of bonds down to a conservative ratio of the total investment. The business is, however, a growing, not a static, one and its bonds can be kept as sound as they are now only if the industry shall be able to raise equity money in future as successfully as it has in the past. No one has a more direct interest in the equity health of the utilities than the bondholder. The purpose of my talk has been to impress this thought upon you as large bond investors and to bespeak your support, in your own interest, of a line of public policy with respect to the electric utilities which, while regulating them strictly in the public interest, will not be punitive or destructive.

The utilities have been accused of fighting government regulation. Such is not the case. We recognize that regulation is not only necessary in the public interest, but that in the end it has a stabilizing effect on the market for our securities. We have the analogy every day in our physical operations, where every machine is equipped with a governor or regulator. If the governor regulates too little, the machine will run away and destroy itself; if it regulates too much, it will shut the machine down. We hope that the new Federal Government regulation now getting under way will on the one hand prevent all runaway excesses of the past, but on the other hand will not throttle the utility machine to the point of shutting it down. A combination of patience, frankness and statesmanship should accomplish this golden mean, which means the best for all parties served, the investor and consumer.

I desire to end on a note of reasoned optimism. I have been engaged in the electric utility business for nearly 35 years. From long observation I know the people of this country can be relied upon to be fair when they know the facts. Their interest in our business has been and must necessarily be limited to getting from us the best possible electric service at the lowest feasible cost. The record the utilities have made in the last decade in rate reduction and extension of facilities to which I have referred has been reflected in a mounting public verdict for our service as compared with government ownership. Out of the 22,638,000 votes cast in the last five years in local elections where this question was at issue, the per cent favoring government ownership fell from 70.5 per cent in 1933 to 11.5 per cent in 1937. This is the best answer to our critics because it is the most convincing one.

Generator Insulation Tests

(*Continued from page* 206)

However, periodic readings may indicate a trend of the general condition.

3. There is at present insufficient data to permit accurate correction of insulation resistance readings for all factors affecting these readings.

4. Slope of the resistance time curves may be of value as an indicator of insulation condition. At present there is insufficient data to verify or disprove this.

5. Power factor tests have given little indication of value in locating faults or incipient faults in generator windings. However, power factor measurements may prove to be an indicator of the trend of the general condition of the insulation of a given machine if records are kept of periodic readings. Here, also, insufficient data are preventing verification.

6. 60 cycle breakdown tests themselves give only a general indication of the condition of a particular winding and the balance between slot and end turn insulation. Since most tests of this type will be conducted on windings of old classes of insulation it is not felt that the tests are particularly valuable unless correlated with non-destructive tests.

7. 60 cycle ionization tests have given no indication of value in predicting general condition of generator insulation or locating weak spots in windings.

Recommendations

1. Insufficient data are available to establish the relation between "Spot" readings of insulation resistance, insulation resistance slopes and power factor and the life of generator insulation. Every possible opportunity should be taken to secure data on these characteristics.

2. Insulation resistance or power factor readings should be taken periodically and referred to a common basis in order to detect changes taking place during the life of the insulation. These may be secured by testing existing machines, particularly new machines as they are placed in service.

3. Further data should be secured to indicate the effects of moisture and the temperature of various types of insulation on insulation resistance and power factor.

4. High voltage d-c (3000 to 15,000 volts) insulation resistance tests should be investigated thoroughly.

5. Further efforts should be made to establish relation between non-destructive and high potential breakdown by inflicting deliberate winding insulation injuries during series of tests.

6. 60 cycle ionization detection tests should be discontinued.

7. 60 cycle ionization discharge measurement tests should be discontinued.

E.E.I. Annual Statistical Bulletin is Published

STATISTICAL BULLETIN No. 5, which has just been published by the Institute, is the last of a series of annual statistical bulletins, beginning with the year 1926, which follows the long accepted classification of customers according to rate schedules. Future operating statistics of the electric light and power industry will be made to conform to the new system of accounts promulgated by the Federal Power Commission, in which the classification of revenue accounts has been materially altered. The Institute will publish later this year a restatement of the 1937 statistical data on the basis of the new classification of sales to facilitate a comparison next year of 1938 operating data with 1937 data and to provide some connecting link between the data of the old series and the new.

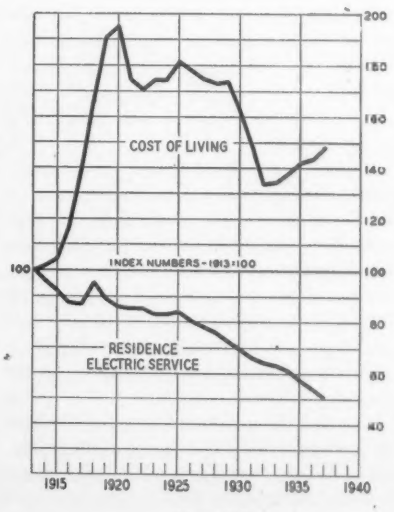
Despite an increase of 114 million dollars in operating revenue, the operating income of the private power companies, the Bulletin states, showed last year a gain of only 5 million dollars, or 1½ per cent increase over 1936. Taxes alone in 1937 amounted to 330 million dollars, or almost one dollar out of every six received from consumers. Taxes paid by the power companies have increased 60 per cent in the past five years.

In summarizing the statistics for the year 1937, the Bulletin shows that sales of electricity approached one hundred billion kilowatt-hours. At the close of the year, the electric light and power industry was serving 27,163,987 ultimate customers of all classes, an increase of 958,108 customers, or 3.7 per cent, over the 26,205,879 customers served at the close of 1936. This is the largest increase in customers connected during any one year since 1929. During 1937, the industry sold 99,446,364,000 kilowatt-hours, an increase of 10.4 per cent over 1936. The revenue obtained for sales to all customers amounted to $2,180,787,600 as compared with $2,044,586,900 in 1936, an increase of $136,200,700, or 6.7 per cent.

Approximately 1,000,000 kilowatts of new capacity was added during 1937. At the close of 1937 the industry had 34,960,321 kilowatts of generating capacity compared with 34,260,071 kilowatts at the close of 1936, an increase of 2 per cent. During 1937 some 970,000 kilowatts of new capacity was installed and about 270,000 kilowatts of older or more obsolete equipment was retired, resulting in a net increase of 700,250 kilowatts for that year.

The total gross construction expenditures of the electric light and power industry, exclusive of Tennessee Valley Authority and other governmental direct operating undertakings, for which information is not available, amounted to $455,480,000 during 1937. This is somewhat less than the average yearly construction for the seventeen-year period from 1921 to date, but about 60 per cent greater than the $289,710,000 expended in 1936. For the first time in several years, expenditures for generating facilities constituted a substantial proportion of the total amounting to $124,000,000, or about one-fourth. Substation and distribution system expenditures amounted to $252,000,000, as compared with $200,000,000 in 1936, much of this money going into new rural line extensions. Several new interconnecting transmission lines were built during 1937. The total expenditures for transmission was about $41,000,000 or double the 1936 figure.

The rapid rise in use of electrical energy in the home which began shortly after the World War, and which has continued except for the lowest part of the depression in 1931-1933, received increased impetus in the past year through the more extensive use of home electric appliances. These appliances have rapidly gone into American farm and urban homes following the aggressive promotional activities of the industry in cooperation with dealers and manufacturers.



The industry has continued with increasing vigor the several promotional programs initiated in the past few years, among which have been the "Better Light-Better Sight," cooperative sales program; the "Electrical Housewares" and "Rural Running Water" campaigns and the forward-looking activity comprising the "Kitchen Modernizing" program. These campaigns have been supported by all branches of the electrical industry and other interested agencies for the purpose of stimulating merchandising sales of electrical equipment by all retail outlets. The electric light and power industry itself merchandises only about 16 per cent of the total volume of all appliances, as is shown by the fact that in 1936 the total volume of merchandise sales (exclusive of radio sets and tubes) amounted to $662,023,000, of which $103,291,000 was sold by electric light and power enterprises and $558,732,000 by other sales outlets.

"National promotional sales programs and the availability of improved appliances at prices within the purchasing power of more and more residential and farm customers have been the principal factors in bringing about the increased household use of electricity, with the accompanying lower average revenue per kilowatt-hour, during the past ten or fifteen years," the Bulletin concludes. "In this respect, the public acceptance of the electric refrigerator and radio has been the largest contributing factor.

"The average urban and non-farm home consumed 793 kilowatt-hours in 1937 as compared with 727 a year ago, an increase of 9.1 per cent. The average revenue per kilowatt-hour was 4.39 cents compared with 4.65 cents, or a reduction of 5.6 per cent. The average annual bill for the calendar year 1937 was $34.81 as compared with $33.81 a year ago. It is conservatively estimated that of the total bill of $34.81 approximately $6.00, or 17 per cent, is paid to the federal, state and local government in taxes."

Approximately a million and a quarter farms were being served at the end of the year. Average farm use in the non-irrigation areas now exceeds 1,000 kilowatt-hours annually, and the average annual farm bill for 1937 was $47.86.

Our Goal From Here

In Better Light-Better Sight

By Merrill E. Skinner

Vice President, Buffalo Niagara & Eastern Power Corp.

An address before the Fifth Annual Sales Conference, Edison Electric Institute, Chicago, Ill., March 29-April 1

IN formulating objectives for the future of any activity, an examination of the record of the immediate past is always desirable. It is almost five years since the electric utility companies of the country initiated the Better Light-Better Sight movement. It was at the Chicago Convention of the Edison Electric Institute in June, 1933, that it was first suggested that the utilities marshal their forces for a lighting drive.

When the suggestion was offered, it was conceived not as an inter-industry program but primarily an effort on the part of utility companies, aided by the manufacturers of incandescent lamps, to give the lighting business a shot in the arm. We were then in the depths of depression and everyone felt that under prevailing conditions our best prospect for bolstering dwindling revenues lay in the promotion of lighting to our residence customers.

The program was initiated under the direction of a special committee appointed by Mr. Whitwell, who was then Chairman of the Sales Committee, and, during the summer of 1933, a plan was developed to marshal the activities of utilities throughout the country behind this lighting drive. Fortunately there existed a combination of business necessity to furnish the driving force for the activity and the timely availability of correlated scientific data which soon put us on the track of a much broader operation. After only a few months had elapsed, the utilities and the manufacturers realized the broader aspects of the program which they had initiated and so, in March, 1934, the special committee presented to the Sales Committee at Chicago the outline of what we now know as the Better Light-Better Sight Bureau.

During the Spring and early Summer contacts were made with other groups whom we felt we could interest and, on August 1, 1934, the Better Light-Better Sight Bureau was formed as a voluntary association of those who had an interest in light and sight. At that time the activities of the utility companies and of the manufacturers were rededicated to the broader purpose of educating the public to all phases of the question of seeing. What results have followed in the wake of this activity which has now been going on for almost five years?

MR. SKINNER

First, I would cite the sympathetic support of the co-sponsors of the Better Light-Better Sight Bureau in advancing our objective. This has resulted in a tremendous multiplication of the factors which influence customers to adopt the Better Light-Better Sight philosophy and to do something about it.

A second major accomplishment has been the renaissance in lighting design and application. I know of no period in the history of the electric lighting business in which we have seen such rapid strides made in the improvement of illuminants, in the scientific design of lighting fixtures and equipment and in the scientific application of electric light to human problems. The I.E.S. Better Sight Lamp program is probably the outstanding illustration of the influence which has been brought to bear in improving the quality of illumination from portable lamps and, while only 3,000,000 portable lamps have been certified and tagged, the influence of the so-called I.E.S. specifications has spread to practically every phase of portable lamp and fixture design.

We have put the sale of lighting on a scientific basis supported by verified research and the universal testimony of those in the lighting business is to the effect that at no time has the customer been so ready and willing to accept recommendations for improved lighting.

During the five-year period in question, there has been a tremendous stimulation of utility interest in the promotion of lighting and all phases of the Better Light-Better Sight program. The increase in personnel is tremendous and this trained group of utility people are not only promoting lighting but also are giving a helping hand to the interests of the other groups who are associated with us in the movement and who are co-sponsors of the Bureau.

I could go on and on detailing accomplishments, but to most of you it is a familiar story. The amazing thing is the spread of this gospel into every nook and cranny of the United States and its adoption in most foreign countries. Truly it is a mighty oak that developed from the little acorn planted here in Chicago five years ago, and all of this has been accomplished on an annual budget for Bureau expense of less than $20,000 per year.

The latest recognition which has come to the Better Light-Better Sight activity is the endorsement by *Hygeia* magazine published by the American Medical Association. A year ago, Dr. Fishbein consented to talk before the Annual Convention of the E.E.I. His inspiring and interesting talk was one of the highlights of the convention. During the winter there have appeared in *Hygeia,* which is the consumer publication of the American Medical Association, a series of five articles on light and sight. The final of the series appeared in the March issue. These articles have been written by medical men of outstanding reputation. It is the intention of the Bureau to reprint this series of articles, together with biographical sketches of the authors and with a foreword by Dr. Fishbein. If there remain in your territory any doubting Thomases who feel that the Better Light-Better Sight appeal is supported only by the work of selfishly in-

terested research laboratories this testimony from the American Medical Association should put an end to all such arguments.

Based upon the foregoing five-year record of accomplishment, I believe we should establish four major objectives for the future as follows:

1. To nurture and keep alive this accurate, truthful and scientific approach to the sale of our product. The strength of our sales appeal lies in its integrity and every utility man should guard jealously the accuracy of the facts used to promote the sale of lighting. If we are led into exaggeration it will quickly destroy the splendid public confidence which has been built up so painstakingly during the past few years. With success, there is always a tendency to let up on the fundamental story which has brought that success about. In our efforts to find something new and novel to present to the public, we are prone to drop back to emphasizing details of equipment instead of benefits to people. Our momentum might carry us on for a time but new prospects are only created when more people understand how they can benefit from the use of Better Light for Better Sight.

We also have a duty to the other groups who are co-sponsors with us in the Better Light-Better Sight movement. We are getting a great deal of help from these other groups and it is only sporting to reciprocate that help by giving their story a boost at every convenient opportunity. We can do this in so many ways, and so easily, if we will just keep the matter in mind and give it the attention it deserves.

2. We should accelerate the acceptance of Better Light-Better Sight in practice as well as in theory. Many thousands of individuals and institutions have now thoroughly accepted the theory of Better Light-Better Sight but as yet have done nothing about it. The reasons are numerous, probably the most common one is lack of funds. As an illustration of this point, I would say that there are thousands of school authorities throughout the country who now recognize clearly the inadequacy of the lighting in schools under their direction. They intend to do something about it some time, but with tax burdens already high, it is impossible to secure funds to correct the lighting conditions. The important thing is not to let them forget about it. If we let up, other pressing needs will come to the front and when the funds do become available, the lighting is likely to be forgotten.

3. We should endeavor to expand the use of Better Light-Better Sight by extending its application in every conceivable field. We have seen it grow from the home to the office, to the factory, to the school. At the present time we are on the threshold of a great movement for highway safety through proper highway lighting. This is typical of the many fields to which the principles of Better Light-Better Sight can be extended.

4. Finally, let us not forget that the application of Better Light-Better Sight to the home has the broadest influence. Wherever people may work they always live in a home and if they understand the application of Better Light-Better Sight to their home environment they are certain to sense the way in which it can be applied to their office or their work.

There is increasing evidence that the safety appeal is an important one in home lighting. We have talked so much about highway safety that we are prone to forget that more people are killed each year in home accidents than are killed in highway accidents and only a cursory examination of the cicumstances would indicate that lack of proper lighting is an important contributory factor to these accidents.

We are told that Better Light-Better Sight demonstrations have been made in 5,000,000 homes since we started the activity. This would still leave from 15,000,000 to 20,000,000 homes which have not yet received a full knowledge of the true significance of Better Light-Better Sight. They may have read something about it; they may have come in contact with it in some other way; but it is not until the home lighting advisor actually demonstrates with light meter and equipment the application of Better Light-Better Sight to the specific home environment that people really appreciate what it is all about.

This activity, starting as a shot in the arm for the lighting business, has now developed into a continuing, ever expanding program of activity. It has seemed to me for some time that it would be unfair to have a perennial chairman. A fresh point of view will frequently inject new life and new angles and I believe that a change in the administration would be helpful. Accordingly, I requested the Executive Committee to be relieved of the chairmanship and at the Annual Meeting of the Bureau held yesterday, Mr. C. A. Eastman, of New York, was elected as my successor. He has had a tremendous personal interest in the Better Light-Better Sight program and through the many companies with which he is associated, there have been most substantial contributions made to the progress of the movement. I know its future lies in capable hands and I only bespeak for him the wholehearted cooperation and support which I have enjoyed on every hand throughout the entire period in which I have served as Chairman.

Electricity's Place in the Golden Gate Exposition

(*Continued from page* 242)

searchlights, spotlights, perimeter lights, cylindrical lanterns from 60 to 75 feet in height and 6 feet in diameter, special units for lagoons and fountains and steam urns, moonlight effects and a long list of other marvels. Fluorescent tubes —a development not yet on the market —will be used extensively. The tubes are filled with gas and provide remarkable floodlighting in pink, blue, green and white. Another innovation will be the use of ultra-violet light on fluorescent paint to give "life" to murals and sculptured relief work.

Lighting "stunts" will be few, for the intention is to treat Treasure Island as a whole and to paint, by a unified program of illumination, one great picture of pageantry, fantasy and mystery. The outstanding exception will be the reproduction of "Old Faithful" with large projectors painting its 150-foot column of water in varying hues. The background for this will be an aurora of scintillating beams from two dozen 36-inch searchlights.

The illumination scheme will make generous use of color—white, amber, lemon, yellow, green, apricot, gold, peach, pink, blue and red—but each of the courts will be held to two or three harmonious shades.

The wizardry of the illuminating engineers will, of course, cover the whole Exposition—all the courts, all the palaces and temples, all the concourses and areas. It will cover, too, all the gardens and landscaping, making flowers and trees and shrubs even lovlier at night than by day. It will cover even the exterior walls and entrance gates.

Five Years Progress of the Better Light-Better Sight Movement

As reported to the E.E.I. Sales Conference March 29th by five Utility Commercial Executives representing the five sections of the U.S.

THE SOUTHEAST

By C. A. Collier
Georgia Power Co., Atlanta, Ga.

MR. COLLIER

IN the short period of five years, acceptance of the Better Light-Better Sight program by southeastern utilities and their customers has been nothing short of phenomenal!

A study of the progress in Better Light-Better Sight, not only in my company but in a representative number of other companies from Maryland to Florida, has revealed an interesting, even startling, series of facts.

Five years ago, utility officials, let alone Mr. Average Citizen, knew little or nothing about the Better Light-Better Sight program. Yet, within the short space of a few years, it can be safely and accurately said that today in the Southeast 60 per cent of the public is Better Light-Better Sight conscious! Who would have dared predict so rapid a growth, so wide an acceptance of this infant of the electrical industry in so short a time?

What have been the policies and programs carried on by southeastern power companies to create this quick acceptance?

First of all, close cooperation of electrical interests—electrical contractors, dealers, and jobbers, etc.—was attained by the utilities. Programs and meetings have been held at which the Better Light-Better Sight story was told and sold to them.

Secondly, the Better Light-Better Sight story was taken to the optical group which has cooperated splendidly in furthering the progress of the Better Light-Better Sight program. A third group, the paint interests, was brought into the picture by many utilities.

Taking these three groups together, it seems that the heaviest emphasis has been placed on the electrical interests, and that the optical interests received a little more attention than the paint interests. As a whole, the Better Light-Better Sight story has been delivered to most of these allied interests in a comprehensive and thorough manner.

I have told you that public acceptance of the Better Light-Better Sight movement has reached a peak of 60 per cent of the public at large in the Southeast. This fine acceptance on the part of the public has been accomplished by both educational and commercial activities. It is impossible to say what percentage of the activities have been commercial and what percentage educational as it is difficult to draw a clear line of demarkation between these two activities. For example, activities which may be referred to as commercial because they are designed to sell are also educational. However, speaking in general terms, it appears that activities on the whole have been somewhat more educational than commercial.

It is natural to expect a sizable increase in utility personnel as a result of the growth of the Better Light-Better Sight program. But it is, at the same time, rather surprising to find so large an increase. Today the lighting personnel of the southeastern utilities is approximately 430 per cent of what it was five years ago—four times what it was in 1933.

Paving the way for the sale of better lighting has been a specific duty for lighting department personnel. To do that, talks have been made to women's clubs, church organizations, business women's clubs, home economic clubs, P. T. A.'s, school groups, eyesight specialists' groups, Rotary clubs, Kiwanis clubs, merchants' associations, garden clubs, bridge clubs, sewing clubs, book clubs, and every other conceivable type of organization where there might be an interest in Better Light-Better Sight. Many utilities have supplemented their talks and demonstrations with moving pictures.

To give you an idea of the thoroughness of this type of work, let me say that in the territory served by the Georgia Power Company, where we have approximately 160,000 residential customers, a total of 66,000 customers improved their lighting on recommendations of our home lighting department and 57,000 persons attended lectures on Better Light-Better Sight during the past five years. In Memphis alone, which is, of course, served by the Memphis Power and Light Company, 110 groups representing a total of 12,736 persons were addressed in 1937 on Better Light-Better Sight.

Many and varied advertising programs have been carried on by southeastern utilities. Every medium has been used—newspapers, radio, direct mail, hand-out literature, billboards, bill enclosures, and even motion pictures in local theaters.

One southern utility spends a total of

25 per cent of its advertising budget on advertising Better Light-Better Sight. All of them extensively advertise it. Most of them tie-in with the national advertising program carried on by the council and by the manufacturers.

Only three or four southeastern utilities have either a local Sight Saving Council or similar organization.

In Memphis there is a shining example of what constitutes a progressive, active, helpful Sight Saving Council. It was organized in 1934 as the Memphis Better Light-Better Sight Bureau, and was reorganized in 1936 as the Sight Saving Council of Memphis.

Membership in this organization consists of civic leaders and others interested in sight preservation. From its inception the Council did not regard its work as a "campaign," but rather as a movement to be carried on permanently for years to come.

Accomplishments of the organization during its first year are wide in their scope, running from addresses to many thousands on eyesight conservation, furnishing 41 pairs of glasses to needy children without charge, running newspaper and radio advertising on conserving eyesight, to the installation of a Sight Saving Class Room in one of the schools. The comprehensive work and the methods of carrying it on by this council are worthy of study by everyone interested in Better Light-Better Sight.

And what has been the result of the Better Light-Better Sight programs carried on by utilities from the standpoint of increased load? Most utilities make spot checks from time to time. In our own company we make a spot check each year. Our last check made on slightly more than 1,000 residential customers who had increased their wattage as a result of the efforts of our home lighting department, showed an annual increase of 177.5 kwhr per customer resulting in additional annual revenue of $6.02 per customer.

In Memphis a check of customers purchasing I.E.S. Lamps in 1936 showed an average increase of 115 kwhr annually, and a similar check in 1937 showed an annual increase of 188 kwhr annually.

Practically every utility in the Southeast has made some form of tests from time to time to determine the tangible results being secured from the program and I believe I am safe in saying that in every instance the results have been

(*Continued on page* 248)

THE SOUTHWEST

By E. H. Holland

Vice President, Dallas Power & Light Co., Dallas, Texas

THE summary which it is my privilege to submit represents a cross-section of the Better Light-Better Sight Activities in an area which extends from the Ozark Mountains of Arkansas to the Salt River Valley of Arizona, and from the Texas Panhandle to the Gulf of Mexico.

The name Southwest suggests wide-open spaces and rightly so. With the exception of the few large cities the population density is small and likewise electric service customers are frequently few and far between. Nevertheless I am glad to be able to report that according to information secured from 13 representative electric service companies serving over a million meters in this area, the Better Light-Better Sight story has been carried successfully in some form to every community, regardless of size.

It is true that many people in our section still do not appreciate the full significance of the Better Light-Better Sight Program, although they may recognize the name and may have even purchased I.E.S. lamps. In general it is believed that approximately 50 per cent have been effectively reached and that the remaining half still offers an opportunity for lighting promotion.

The method of developing the Better Light-Better Sight Program by the reporting companies showed a remarkable consistency. Without exception cooperative policies and programs were carried on extensively. Electrical contractors, retail and wholesale lamp dealers, eyesight specialists, paint and wallpaper contractors, all have been made an integral part of the local programs. This cooperative effort has not only increased the sale of lighting equipment and energy but it has made many new and permanent friends for the whole electrical industry; friends who for the first time appreciate the character of men in the business and the type of work which they are doing.

A marked tendency toward greater emphasis on sale of equipment by dealers rather than the utility, especially in the larger cities, has been shown. This trend is expected to broaden its scope as rapidly as dealer outlets are developed in the smaller towns.

Programs in general have been jointly educational and commercial with about equal value placed on each. With only one exception the number of employees engaged in lighting work either on a full or part-time basis has been increased materially. Now, approximately 13 times as many lighting sales people are telling the lighting story as there were in 1933.

Wide use is being made of lecture programs. Apparently the P.T.A. groups offer the most appreciative audiences because all companies reported these organizations at the head of their lists. Civic clubs, schools, and professional groups are being told the story of eyesight conservation, and even after five years these lectures continue to be received with enthusiasm, undoubtedly because of the genuine sincerity of purpose on which this movement was founded.

Every available media that the fertile minds of advertising men can conceive apparently is being utilized in publicizing this program. Ideas range all the way from book markers for school children to elaborate pageants and moving pictures. In by far the greatest majority of cases the theme is the same, namely, what proper lighting can do toward conserving eyesight.

The use of "sight saving councils" has been limited since only two such organizations were reported and these are in the larger cities. Preference seems to be for more informal organizations growing out of meetings conducted in company home service auditoriums and halls.

The problem of accurately accounting for the commercial benefits of the Better Light-Better Sight Program, as well as for any other of the many utility services, is one that gives most companies great concern. Such factors as the replacement of existing equipment, hours of use, and "load mortality," make estimating at best a hazardous task. In many cases dealer and company sales reports serve as a basis for determining results. If this information is supplemented by periodical meter-book checks, and analyses of average wattage of bulbs sold, a reasonably reliable conclusion can be drawn. In spite of this difficulty all companies reported entire satisfaction with the results obtained and that the time, effort, and money expended was

well repaid. The commercial benefits derived through the revitalization of the entire portable lamp industry are, of course, well known and certainly apply to the Southwest.

Many outstanding specific activities were reported. The sale of I.E.S. lamps by dealers, raising average wattage of bulbs sold, correcting school lighting—to name a few. However, the most important, from a long range standpoint, is that of the creation of a widespread "light consciousness." People who had never before given thought to the care and protection of their own or their children's eyes now consult an eyesight specialist regularly, as well as take pains to provide proper seeing conditions in their homes, offices, factories, and schools.

Looking to the future we find all companies in complete agreement as to the need and importance of the broader development of this program for the next five years. Such expressions as "we are barely started," "we will continue on a more extensive basis," "more emphasis on lighting than ever before" indicate more clearly that the Southwest recognizes and appreciates the value of carrying on the Better Light-Better Sight program on a greater scale.

To those of us in the utility business another important factor has arisen in recent years. In the past many companies have established generating station yearly peaks during the winter months. With the advent of the domestic and commercial electric refrigerator, and later the wide acceptance of air conditioning, this so-called "summer valley" in the load curve no longer exists. In fact, station peaks have started shifting to the summer months. Many refrigeration loads have a relatively small yearly load factor and as a result a high system demand is established for a few summer months, then discontinued. The result is that a small return on the investment per kw of generating capacity is likely unless some offsetting load is secured for wintertime operation. What does this have to do with Better Light-Better Sight? Briefly this—Lighting is naturally a greater wintertime than summertime load. With shorter days, inclement weather, better radio entertainment, and studying to do, what offers a better opportunity for wintertime promotion than does lighting?

In conclusion I can truthfully say that the Southwest does look to the Better Light-Better Sight Program for many things in the years to come.

THE NORTHEAST

By Julius Daniels

Sales Manager, Boston Edison Co.

MR. DANIELS

I HAVE to report on the Eastern utilities. All companies, some 20 in number, have responded generously with information which is herewith summarized:

1. To what extent do you estimate your public has been made Better Light for Better Sight conscious?

Answers to this question from companies in this section of the report range from 1% to 60%, with an average guess of perhaps 25% of total public consciousness. In the words of Ralph Wagner of New York Power & Light, "There is no question that national advertising and magazine articles and promotion by the utilities on the subject of Better Light for Better Sight has awakened the general consciousness of the public as a help for seeing."

2. Have cooperative policies and programs been carried on between your company and local optical professions, paint interests, and other electrical interests?

In general, cooperative programs in varying measure have been carried out.

Of the 20 reporting companies, 11 are cooperating actively with the optical profession, 10 with the paint people, and 9 with local electrical concerns. Contact is maintained largely through both regular group meetings and individual contacts.

3. Have your company efforts with the public been jointly educational and commercial or just commercial? If the former, in what proportions?

Uniformly, utility company promotion has been on a jointly educational and commercial basis, with average emphasis about 50-50. This emphasis, however, while averaging 50-50, is actually all over the map. For instance, the Danbury Electric Company's activities are almost entirely educational, and similarly with Pennsylvania Power & Light, and Metropolitan Edison at Reading, Pa. On the other hand, Public Service of New Jersey leans 90% to the commercial, and similarly with Central Maine Power.

4. What is the personnel of your lighting department as compared with five years ago?

Expansion in personnel is rather startling, being uniformly 2, 3 and even 5 times as large as five years ago. In a town the size of Rochester, N. Y., 9 men are now operating on commercial lighting and 14 girls on Home Lighting. In the Albany, Troy, Schenectady area of New York Power & Light, 30 Home Lighting advisors are now maintained. In the western end of New York State, Buffalo Niagara & Eastern employs 65. Philadelphia has increased Home Lighting representatives from 9 to 41 in the past five years. In Allentown, the Pennsylvania Power & Light have increased personnel from 15 to 75 people who directly or indirectly promote Better Light for Better Sight.

5. To what extent have talks on Better Light-Better Sight been made? To what groups?

Practically every electric utility in this section is doing a concentrated job in giving these talks to various groups, including civic clubs, men's and women's clubs, 4-H clubs, Parent-Teachers associations, church groups, cooking classes, Model Home visitors, home bureaus, granges, etc. In Augusta, the Central Maine Power gave 16 such talks last year. Rochester Gas & Electric have given 150 to 23,400 people since 1934. Cambridge Electric Light averages about 10 a year. Narragansett Electric at Providence, R. I., averages about 1 a week during the lighting season. Duquesne Light at Pittsburgh have in the past five years presented talks to about 200 groups totaling 35,000 people.

A really remarkable record!

6. What has been the nature of your advertising and promotions on Better Light-Better Sight?

Advertising has generally taken full advantage of newspapers, radio programs, bill enclosures, direct mail, store and window display, truck signs and billboards. Central New York Power at Syracuse, for instance, has stressed Better Light for Better Sight in at least 60% of its 3-times-a-week radio show during the past two years. The West Penn Power Company has run lighting advertisements twice monthly in a list of 75 newspapers—featured lighting four months out of the year on 53 illuminated billboards.

In commercial and industrial fields, such companies as Boston Edison, West Penn, Central New York Power, and Philadelphia Electric, mail printed material to various groups of prospects on a regular schedule.

As to promotions . . . I. E. S. lamp campaigns, cooperatively with dealers, have predominated. Connecticut Light & Power, Central Hudson Gas & Electric and Duquesne Light are among those who have stressed this activity.

7. Is there a local sight-saving council or

equivalent organization? Describe briefly its operations.

In general, the answer is NO. Even where such a bureau was originally set up, it has been inclined to become inactive as a group project. This is true in the case of Philadelphia Electric, Central New York Power, and Public Service of New Jersey. In Syracuse, Rochester, and Buffalo, New York, only, have these Bureaus proved successful. Here they appear to be proving very effective, establishing sight-saving classrooms in the schools, and so on. In Buffalo, the Bureau sponsored a Sight Conservation Week last year. In Rochester, full page publicity stories, tying-in with advertising by the optical profession, utility and electrical trade, have been run periodically with real success.

8. What checks and studies have been made to determine the commercial benefits accruing from local Better Light-Better Sight activities?

Admittedly, there is no infallible, rule-of-thumb way to measure exactly the KW increases produced by Better Light-Better Sight activities. Ten of the 20 companies in this section, however, spot-check and analyze the bills of customers who have had lighting improvements actually installed as a result of promotion. A number of the other companies have gauged their progress by recording increases in I.E.S. lamp sales during the five-year period, as well as by the increasing number of requests from customers for Better Light information and service.

Specifically, the Connecticut Light and Power Company estimate 20% to 40% increase in load among the low-bracket domestic groups. In the commercial field, West Penn Power Company show an increase from 591 kw sold in 1934 for Interior Lighting to 1993 in 1937 . . . from 46 to 254 for Window Lighting. In the sale of I.E.S. lamps, Central New York Power reports the sale of 8000 lamps to 60,000 Syracuse residential meters in 1936 and 12,000 in 1937—one out of every three homes in only two years.

9. What are the accomplishments or activities that you consider particularly outstanding during the past five years?

Summarizing a wide variety and degree of accomplishment, outstanding activities line up as follows:

Gains in the volume sale of I.E.S. lamps.

Cooperation of oculist, Parent-Teachers, Home Bureau and other groups by means of Better Lighting Bureaus, group-talks and individual contacts, thus achieving a general welfare movement.

Cooperative activities with electrical trade.

The work of home lighting specialists in contacting customers.

Improvements in school lighting.

Use of light meters.

Acceptance of higher intensity levels by commercial customers and architects.

Improved consciousness of Better Light for Better Sight by own employes.

Home Lighting Exhibit.

Engineered safeway highway lighting.

Improved office lighting.

Use of larger wattage bulbs, increased lighting load and revenue, and improved public relations because of the service rendered.

10. What do you predict will be your attitude and activities on Better Light-Better Sight in the future—from one to five years?

Practically every company plans continued activity and added concentration in practically every promotional phase.

Brockton Edison plans in 1938 to triple its 1937 I.E.S. lamp sales. Hartford Electric Light intends to intensify its educational work. "There is no present indication that we are reaching the point of diminishing returns . . . we're likely to continue at the present rate for several years to come," *states P. H. Powers of West Penn Power.* "We see no reason to anticipate any deviation from the present trend, though some adjustment of emphasis in the various fields of promotion may be called for," says Joseph McKinley of Duquesne Light. "I should think," concludes Merrill Skinner of Buffalo Niagara & Eastern Power, "that we could embark upon a second five-year plan with the greatest enthusiasm, and with a full knowledge that the outcome will be highly profitable."

THE MIDDLE-WEST

By J. E. North

Director of Domestic Sales, Cleveland Electric Illuminating Co., Cleveland, O.

MR. NORTH

AS one who has been vitally interested in the organization and operation of the Better Light-Better Sight movement, the task of assembling the material for this report has been both pleasant and enlightening.

Let me take this opportunity to thank each of those who were good enough to assist me by promptly filling out and returning the questionnaires. It has been most gratifying, and indicative of the keen interest that many companies have in Better Light-Better Sight, to report that of the 34 companies addressed, replies were received from 28. This prompt response and the concise manner in which the questions were answered, made simple what could have been a tedious job.

Let us examine the questions in order.

Question No. 1 "To what extent has the public been made Better Light for Better Sight conscious?"

The highest percentage reported was 75, the lowest 25, with an average of all companies reporting of 52%. Many of those reporting indicated they felt their estimates extremely conservative inasmuch as they believed that national advertising, and publicity, had undoubtedly reached *many more* people than any local survey could accurately measure.

Question No. 2 "Have co-operative programs been carried on between your company and local optical professions, paint interests and other electrical interests?"

Approximately 90% of all of the companies are actively cooperating with local paint and optical groups. Twenty-six of the 28 companies reporting are cooperating with local electrical groups. Due to the nature of promotions, it is safe to say that *all* companies are cooperating, directly or indirectly, with their local electrical trade.

Question No. 3 "Have your company efforts with the public been jointly educational and commercial or just commercial? If the former, in what proportion?"

An average of the results given indicates that 54% of the local activities have been of an educational nature and 46% of a commercial nature.

Question No. 4 "What is the personnel of your lighting department as compared with five years ago?"

Although the question asked for the personnel five years ago as compared with today, some companies gave figures covering only three or four years. In these cases, the percentage increases were figured over this shorter period rather than over the five-year period. Where no lighting departments existed prior to the advent of Better Light-Better Sight, the increase was estimated arbitrarily at 50%.

A wide variation is seen in the extent to which lighting departments have been increased during the last few years. The highest reported is 4,000% (1 to 41 people), the lowest 50%. The average for all companies is approximately 500% and gives an accurate picture of what the growth has been in general.

Question No. 5 "To what extent have talks on Better Light-Better Sight been made? To what groups?"

Each of the 28 companies have maintained

a lecture bureau or have provided speakers to present talks on Lighting, Eyesight Conservation and other related topics. Typical audiences include women's groups, civic groups, professional groups, and student groups. Large numbers of employee groups also have heard lectures of both a sales and educational nature.

Question No. 6 "What has been the nature of your advertising and promotions on Better Light-Better Sight?"

The specific details of many of the advertising and promotional activities used were not given on the reports received, due, no doubt, to space limitation. However, the summary shows that almost without exception, each of the companies has employed almost every worthwhile medium at their disposal to publicize Better Light-Better Sight. Included have been newspaper advertising, radio talks, consumer literature, exhibits, films, billboards, direct mail, bill enclosures, car cards, contest folders, house organs and newspaper publicity. The size of the towns and the nature of the territories served were largely the factors which determined the nature and style of individual or local promotions.

Question No. 7 "Is there a local Sight Saving Council or equivalent organization? Describe briefly its operations."

There are four Sight Saving Councils, as such, functioning in the territories served by reporting companies. There are four other "equivalent" groups who function in much the same manner as a Sight Saving Council. Seventy-two per cent or better than two-thirds of the replies indicated that no type of Sight Saving Council or similar organization existed.

Question No. 8 "What checks and studies have been made to determine the commercial benefits accruing from local Better Light-Better Sight activities?"

Twenty-two companies have made an analysis of their individual operations. Only six companies indicate that no actual check or test has been made, or completed to date. Although few detailed results were included, several interesting comments were made as to the results being obtained. These include:

1. A check in 1/3 of all homes where lighting improvements were suggested, which showed that 70% of the recommended changes had been made by customers.

2. A tabulation of results from all of the homes in which lighting improvements had been made which indicated that over 28,000 additional kilowatts had been installed.

3. Actual sale of over 109,000 Sight-Saving type lamps (in one city).

4. Relative increases from new lighting prior to and with Better Light-Better Sight as follows:

1932	4,000 kw
1937	22,000 kw

5. A survey showing that at present, 63% of all portable lamps being sold in one town were of the I.E.S. or Sight-Saving type.

Question No. 9 "What are the accomplishments or activities that you consider particularly outstanding during the past five years?"

It is difficult to place a figure on the outstanding result of an operation of this na-

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THE PACIFIC COAST

By E. G. Stahl

General Sales Manager, San Joaquin Light and Power Corp.

MR. STAHL

LOOKING back upon lighting sales and comparing present methods and results with those of previous years, we find that much progress has been made in the West during the past five years.

The Better Light-Better Sight Campaign has not only united for a common objective all branches of the lighting industry, but has enlisted the active support of such allied groups as the paint manufacturers, eyesight specialists, school authorities, safety organizations and others into a great movement for better seeing conditions.

Within our own industry, as a result of the Better Light-Better Sight activity, we have seen a decided improvement in lighting equipment, so that today efficient, correctly designed equipment is available to meet any requirement. Better Light-Better Sight has been the inspiration for improving our selling methods with the result that we now have trained men and women selling correct illumination in contrast to utility lighting equipment peddlers of a few years ago. Better Light-Better Sight, through its great advertising campaign and its cooperative organizational efforts, has made the public lighting conscious.

The plan from the start was destined to be a success because it was well organized and directed, because the field was a fertile one and because it has been consistently carried on over a period of years.

The Utilities have a double interest in this plan:

First: Lighting offers probably the greatest opportunity and the most profitable field for creative selling of any class of electric service.

Second: The possibility of improved lighting sources of higher efficiencies, plus reduced rates, necessitates the education of the public to higher lighting standards in order to maintain lighting revenues. Fortunately we have a good "margin of safety" to work toward because an increase of 300 per cent in lighting intensities would still be economically sound from the average customers' standpoint.

The response I received from a questionnaire to fourteen of the larger Utilities in the Western part of the United States is evidence of their interest and of the results secured since the advent of Better Light-Better Sight:

1. They report that from 50% to 95% of the public has been made Better Light-Better Sight conscious. One company is telling the lighting story to their customers at the rate of 150,000 per year.

2. Each company reports that it has secured cooperation from the optical profession, paint interests and other electrical interests.

3. Efforts have been jointly educational and commercial, ranging from 80% educational and 20% commercial to 20% educational and 80% commercial, with an average of about 50-50.

4. I believe the feature of these reports that indicates most definitely the Utilities interest in the program is the great increase in their lighting sales personnel. The percentage of increase ranged from 50% upward. One company with no lighting employees in 1933 now has well organized Home and Commercial Lighting Departments. Another company with four employees five years ago now has 114 in their Lighting Department. One company employs a lighting specialist for each 1,250 domestic customers, etc. Incidentally, one of the real problems of Utility Lighting Departments is the selection and training of lighting specialists.

5. All companies reporting indicated speakers were provided for service clubs, P.T.A. groups, Women's Clubs, schools, Farm Bureaus, Granges, etc. The number of group talks per year ranged from 16 to 300 and averaged about two per week per company.

6. Advertising mediums were newspaper, with news stories where possible, radio, direct mail, billboards and booklets. The copy

was about 50% promotional and educational, and 50% merchandising.

7. Only three Sight Saving Councils were reported. They, however, were more or less State wide and covered the territory of about half the utilities reporting. Their principal functions were to collect data, provide speakers and distribute pamphlets; laying a fundamental background for eyesight conservation.

An explanation of the organizational setup and objectives of the Eyesight Conservation Council of Northern California is illustrative of the value of this type of association. The President of the Council is Dr. French, head of the California School for the Blind.

The Council has the active support and cooperation of the Division of School Planning of the State Department of Education. Through the State Department of Education, a booklet has been prepared, covering eyesight conservation, which has been made available to the entire teaching body of the State.

Under the auspices of the council, the fundamentals of good lighting practice, both natural and artificial, have been presented before the teachers' institutes and the State Association of School Trustees. All of this has resulted in many Cities and Counties undertaking complete surveys of lighting conditions existing in elementary and high schools. Later in this report I shall make reference to specific results obtained in my company's territory.

As a result of the interest created by the activities of the Sight Conservation Council of Northern California, experimental studies are being conducted under actual classroom conditions, with proper parallel controls, to determine the economic advantage of better classroom lighting facilities. It has been observed that this educational program has resulted in a definite student demand for improved home lighting. All of this promotional work has been accepted by the school authorities because it has been kept on a strictly non-commercial basis.

8. The commercial benefits resulting from Better Light-Better Sight, as reported by the Western Utilities, were measured principally by the amount of lighting equipment sold and the increased kwhr consumption from meter record checks.

9. Items reported as outstanding accomplishments were:

(a) 45% of customers using I.E.S. lamps.

(b) 50% domestic kwhr increase in five years largely due to lighting sales.

(c) Definite improvement in quality of dealer stocks.

(d) Interest generated among school authorities.

(e) Lighting engineers kept busy meeting demand for lighting service.

In discussing my own Company's activities, naturally I am able to go into somewhat more detail. The San Joaquin Light & Power Corporation serves no large Cities, but supplies service to Fresno, Bakersfield and about 50 smaller Cities and the farming area in the Central part of California. Irrigation pumping and oilfield service is the major part of our business, but we have also given considerable attention to lighting.

Night Sports Lighting

Probably the most spectacular work that has been done was in night sports lighting. Every community with a population of 500 or more has a lighted soft baseball field. During the past five years we have connected 1,210 kw of this class of business, 725 kw for football fields, 330 kw for tennis courts and 285 kw of miscellaneous outdoor sports lighting, making a total of 2,550 kw. In this connection, it is interesting to note the comments of the Probation Officer of Bakersfield, who stated that juvenile delinquencies had decreased to a marked degree since night baseball at the playgrounds became available.

School Lighting

School lighting activities for the past two years have resulted in the modernization of the lighting in 42 schools. The following tabulation shows results of this work.

Our recommended standard is six outlets per room with 500 watts per outlet, which will produce an average of 20 footcandles on the desks.

Before relighting, the average number of outlets per room was two and the average wattage per outlet was 153.

The City of Bakersfield has adopted a modernization program covering the entire 172 classrooms of their elementary school system. This work is progressing satisfactorily. Ten thousand dollars will be available in July to carry on this work.

As a result of the work of our Sight Conservation Council and certain displays we have made, we have been requested to make a survey of the seeing conditions in all of the schools in the City of Fresno. This survey has just been completed and is now being carefully analyzed. Extensive modernization is expected to result from his survey.

There are at present ten new schools under construction that are being wired with six outlets per classroom and in most cases there will be 500 watt indirect units installed.

Home Lighting

Our Home Lighting Department was organized in 1934. More than 20,000 customers have been contacted. Records from careful checks, after eliminating all "the water," indicates that this is a profitable sales activity, producing an annual revenue of more than two dollars per dollar of sales cost. But the outstanding accomplishment of this activity was in connection with the Municipal Ownership Campaign in Fresno a year ago. The 10,000 local contacts made by the Home Lighting girls, in which they secured the confidence and good will of the housewives of Fresno, was a major factor in the two to one defeat of this proposal, which had been organized and built up over a ten-year period by a large newspaper and radio chain, supported by a host of radical politicians.

10. Obviously, in the short time allotted, I have been able to touch upon only a few of the highlights of the Better Light-Better Sight program.

Reports from the Western Companies indicate an increasing interest in this activity. Lighting sales organizations have been expanded and a great amount of thought and effort is being devoted to the training of new personnel. The Red Seal Wiring plan, sponsored by the Pacific Coast Electrical Association, has been revised to meet the demands of improved lighting. Allied interests and educational authorities are cooperating and the public is rapidly learning the value of correct lighting. I think we have made a good start, but we are just beginning to get under way.

The Middle West

(*Continued from page* 239)

ture because of its many far-reaching effects. However, those indicating more than average success that were cited include:

1. The high percentage of homes in which the need for Better Light has been recognized and in which lighting improvements already have been made.

2. The extent to which parents are familiar with the need for better lighting not only in their homes, but wherever their children are to use their eyes for study or close visual tasks.

3. The universal cooperation given local Better Light-Better Sight groups and lighting representatives by members of various optical professions.

4. The extent to which Better Lighting as a factor which influences Eyesight Conservation has been publicized in national magazines, local newspapers and house organs.

5. The degree to which architects and contractors have recognized the desirability of incorporating and planning for Sight-Saving Lighting in new homes and other buildings.

6. The growing number of requests for lighting information and engineering assistance being made by commercial and industrial customers as a result of the lighting educational work done with residential customers.

7. One city in which 166,422 lighting improvements have been made since the beginning of the Better Light-Better Sight movement, a number representing far more than

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This is an official view of the Golden Gate International Exposition, as it will appear from February 18 to December 2, 1939, on its 400-acre Treasure Island in San Francisco Bay. Left foreground is the 110-foot causeway that links the Western World's Fair with Yerba Buena Island and the San Francisco-Oakland Bay Bridge; beyond it are three of the ferry slips that will provide mass transportation of visitors to the $50,000,000 Pageant of the Pacific. Right foreground is the Port of the Trade Winds, 3,400 feet long and 1,500 feet wide, which will be used for small craft and seaplane moorings, marine pageantry and sports, and the "trade ships" of many nations. On the near shore of Treasure Island are three permanent buildings—U-shaped Administration Building, which will become an Air Terminal when the Island, at the close of the Fair, becomes a municipal airport—and two huge hangars which will be used as exhibit buildings during 1939. Beyond them are the great exhibit halls of the Exposition itself, radiating from the 400-foot Tower of the Sun. This view, looking north from Yerba Buena Island, is a painting made by Chesley Bonestell, Berkeley artist.—Gabriel Moulin, photographer.

Electricity's Place in the Golden Gate International Exposition

A MAGIC city is rising rapidly on San Francisco Bay.

It is the 1939 Golden Gate International Exposition.

Here next year, from February 18 to December 2, will be held America's official World's Fair of the West.

This Exposition is a $50,000,000 project, sponsored and supported by the cities of the San Francisco metropolitan area and by the western states.

The purpose is three-fold.

First—To celebrate the completion of the two greatest bridges in the world—the $77,000,000 San Francisco-Oakland Bay Bridge, longest and most costly anywhere, and the Golden Gate Bridge that crosses the harbor entrance with the longest single span ever built.

Second—To commemorate the inauguration of trans-Pacific air service by the huge Clipper Ships.

Third—To depict the progress of the nations bordering on the Pacific.

The site of the Exposition is Treasure Island—a man-made isle in the center of San Francisco Bay, adjoining Yerba Buena Island and between the two huge bridges. It is more than a mile long by two-thirds of a mile wide and contains 400 acres. It was created by the construction of between three and four miles of rock seawall and the pumping of twenty million cubic yards of sand and clay from the floor of the Bay by nine giant dredges. At the conclusion of the Fair the land will be cleared of all structures except a permanent administration building and two vast hangars and will be used as an airport.

Treasure Island will present an inspiring symphony of palaces and towers combining the spectacular features of both Occidental and Oriental architecture.

Exhibit buildings, 100 feet high, will form two double rows running at right angles to each other.

In a great Central Court will be a 400-foot Tower of the Sun.

There will be many more breath-taking courts—the Court of the Pacific, Court of the Seven Seas, Court of the Rising Sun, Court of the Hemispheres, Court of Reflections, Court of the East, Court of the South.

In addition to an International Exhibit Palace, the Fair will have a picturesque group of buildings for participation by foreign governments.

The State of California will expend $5,000,000 on buildings and display areas for educational, agricultural, mining, manufacturing, recreational and vacationland exhibits.

A majestic Electrical and Communications Building, covering two acres, will offer a succession of notable exhibits presenting the electric achievements of today and forecasts of the new marvels of tomorrow. Here will be told in varied forms the dramatic story of the generation of power, its almost limitless uses and the appliances and equipment that convert its energy into conveniences and comforts for everyone.

The Pacific Gas and Electric Company, which serves 1,447,865 customers in 46 of California's 58 counties, will have an elaborate display filling an area of 4750 square feet. One feature will

be an enormous diorama, 190 feet long, depicting the early history of San Francisco and Northern California and, in contrast, all the present-day developments. Six smaller dioramas will illustrate the many services rendered by the Company.

Other firms that already have contracted for space in the building include the General Electric Company, Westinghouse Electric and Manufacturing Company, Bell Telephone Company, General Cable Corporation, Pacific Electric Manufacturing Corporation, Okonite Company, Singer Sewing Machine Company and White Sewing Machine Company.

In the Hall ofWestern States will be a remarkable exhibit sponsored jointly by the Federal Government, the State of California and the private and municipal power companies of the eleven western states with the co-operation of the states themselves. It will be called Industrial West and will consist of a tremendous relief map of the eleven states, built on a scale of one inch to the mile and costing approximately $500,000. On it will be shown all the resources of the west—power generating plants, transmission systems, intensified electrical areas, gas fields, oil fields, gas transmission lines, oil lines, transportation systems, forests, mining regions and plants, timber tracts and mills, scenic points and many other details.

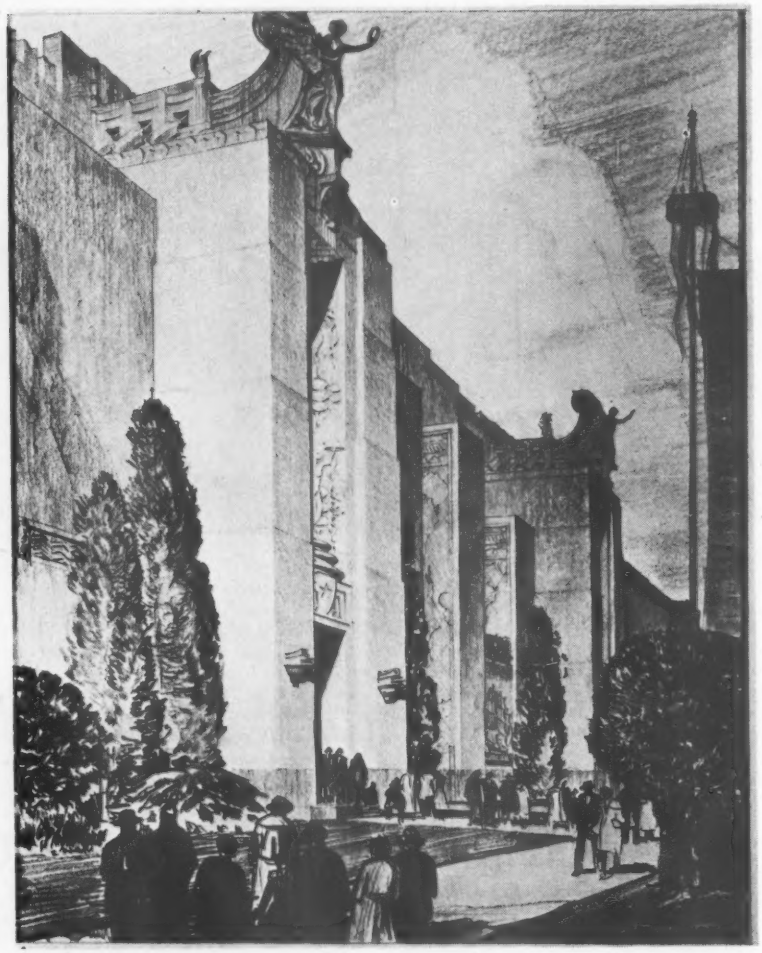
This hall also will accommodate many more displays from every western state and British Columbia. Several midwestern, eastern and southern states will have buildings of their own.

Additional features of the Exposition will include a good-sized harbor for yacht and motorboat races and aquatic carnivals, beautiful lakes and lagoons, an exact reproduction of "Old Faithful" geyser in Yellowstone National Park, dozens of fountains and a 40-acre amusement zone.

As for landscaping—there will be more than five million flowers and twenty thousand trees and shrubs.

Electricity, furnished by the Pacific Gas and Electric Company, has played an important part in the Exposition project from the very beginning. Through the medium of electric dredgers, it helped to create Treasure Island. It is used extensively in the construction of the great array buildings—to operate huge excavating shovels, derricks, material conveyors, air compressors, machinery of all kinds.

Needless to say, electricity will have many vital roles in the completed Exposition. It will run all the mechanical installations, operate fire-alarm and police-signal systems, produce eye-catching novelties in the amusement zone, perform a thousand and one other tasks.



Entrance to the Hall of Electricity and Communications at the 1939 Golden Gate International Exposition on San Francisco Bay. The building opens into the Court of the Seven Seas, and deep architectural niches shown in this sketch will contain submarine scenes, painted in ultra-violet light acting upon fluorescent paint.

But electricity's greatest role will be the illumination of the Exposition—illumination that will establish a new "yardstick" for spectacular wizardry and that will make Treasure Island at night "a magical city afloat on a sea of light."

This glittering scene will be created by two internationally famous illuminating engineers — A. F. Dickerson and H. E. Mahon of the General Electric Company—under the direction of W. P. Day, Exposition vice-president and director of works.

The lighting effects will cost a million dollars and will use about 40,000,000 kilowatt hours of electricity during the 288 days of the Exposition. That's enough, according to Mr. Day, to drive a ten-coach train around the earth 133 times or to the moon and back seven times. It's enough, in every-day terms, to illuminate the streets, serve all the homes and other buildings and operate all the industries in a city of 50,000 population for an entire year.

Power will be supplied through three 9000-foot submarine cables from the Oakland side of the Bay. These lines will deliver electricity to a large substation at the southeast corner of the grounds. Distribution facilities will include about thirty small substations, ten miles of 4000-volt underground feeders, twenty-five miles of street lighting cables and scores of miles of secondary wires.

The Exposition lighting devices will include floodlights of all sizes, powerful

(*Continued on page* 234)

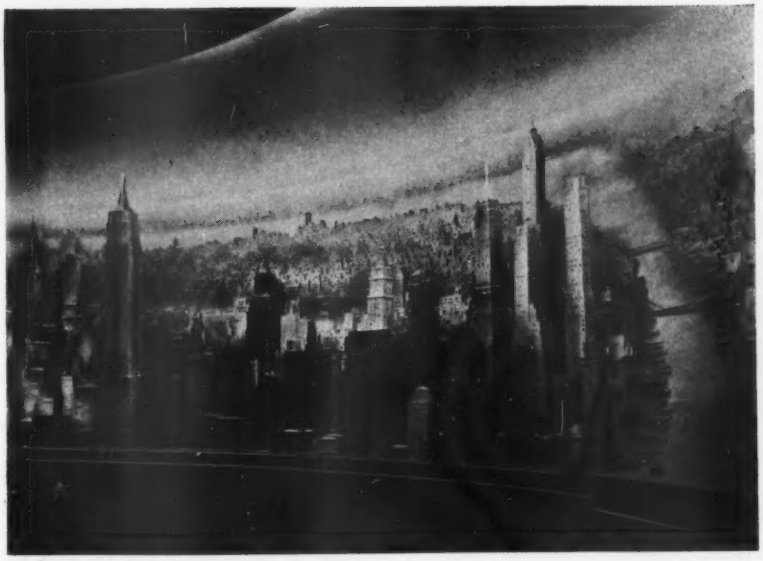
World's Largest Diorama to Show New York's Utilities at World's Fair

THE world's largest diorama—a colored, lighted, animated architectural model of the New York metropolitan area—will be presented as their principal exhibit at the New York World's Fair next year by the Consolidated Edison Company of New York, Inc., and affiliated companies, Floyd L. Carlisle, chairman of the company's board, has announced.

More than 4,000 buildings, studded with 130,000 windows, will be shown in the diorama, whose 204,000-watt illumination will require the most extensive model wiring job on record. Nearly a quarter mile of brilliantly colored neon tubing will represent the city's underground electric, gas and steam networks, while the most complete model subway system yet devised, with trains designed for a "World's Fair run" of 35,000 miles, will provide transportation highlights for the exhibit. Translucent generating station models will suggest the transformation of coal into electricity, gas and steam.

Described as a show, a spectacle, an inspired view of "New York, the City of Light," in emotional appeal suggesting the Hayden Planetarium, the exhibit will be the most elaborate work of its kind ever constructed, combining by means of a totally new exhibition technique, effects drawn from the musical, dramatic and architectural arts. Designed by Walter Dorwin Teague, a member of the World's Fair Board of Design, the diorama will be presented with striking sound effects in cycles dramatizing the contributions of electricity, gas and steam to life in New York. Each performance will crowd into a cycle of twelve minutes the dramatic features of a twenty-four hour period in the metropolis.

The model's length will be nearly that of a city block. Its height will exceed that of a two-story building. From skyline to subway it will provide a realistic picture of New York. Motion, light and sound effects will be synchronized with the spoken word of a lecturer who will regulate the exhibit from a control board resembling the Consolidated Edison System operator's board, nerve center of the world's largest steam-electric power system. To heighten the spectacle's dramatic interest, six-car subway trains, protected by block system safety switches, will speed under the city streets at the scale equivalent of thirty miles an hour. Miniature elevators will rise in Manhattan office buildings, to epitomize the extensive vertical transportation of the city.



Downtown Manhattan section of a model of the world's largest diorama, known as the "City of Light," now under construction for exhibition by the Consolidated Edison Company of New York, Inc., and affiliated companies, at the New York World's Fair 1939. Nearly a city block in length, its height exceeding that of a two-story building, the diorama will show more than 4,000 buildings in the New York metropolitan area. Designed by Walter Dorwin Teague and Frank J. Roorda, Associate, the exhibit is being built by the Diorama Corporation of America, Edward H. Burdick, president.

The illumination of blue, green and yellow tubes will dramatize the underground distribution of electricity; orange and red tubes will represent the flow of gas; white tubes will suggest the passage of steam. Times Square will blaze with light. Ocean liners will lie at river piers. Motor traffic will flow across suspension bridges from Manhattan to Brooklyn. Lighting effects will herald a mid-day thunder storm. There will be shown the gilding of skyscrapers by the setting sun. Transparencies will permit the introduction of a miniature stage production, a hospital operating room and other city life scenes, throwing into bold relief the part played by Consolidated Edison in the community. A "city of the future" preview will be introduced.

A wealth of detail will contribute to the diorama's realism. Certain of the Consolidated Edison System properties will be shown in animated detail. These will include steam-electric generating stations, gas plants and a steam station. Ample space is provided, for the diorama has been designed on the grand scale.

More than 100,000 man-hours of work by skilled craftsmen will go into construction of the exhibit, known to its builders as "the great diorama," to distinguish it from other exhibitions.

The Consolidated Edison exhibit will be housed in a building designed by Harrison and Fouilhoux, who designed the nearby Perisphere and Trylon, the exposition's dominant architectural group. A circular structure of modern design, the building will provide 16,700 square feet of ground floor exhibition space beside administration quarters on the second floor. It will be nearly 115

feet wide by 300 feet long, and will have space for home economics displays as well as entrance, diorama and exit sections. Without windows, it will be artificially lighted and air conditioned throughout. Outside, a garden with amusing features has been planned for children.

Beside the diorama, the exhibition structure will contain a sequence of animated, three-dimensional exhibits intended to illustrate the part played by the utility system in metropolitan area life. Among these displays, designed to catch the visitor's eye as he enters the building, is an "airplane view" map of the New York area, occupying a wall space 52 feet long by 18½ feet high. Nine other displays tell the story of electric, gas and steam service, certain of them dramatizing the work of "Bill Jones," who typifies the Consolidated Edison System's 40,000 employes.

All of the exhibits within the building have been designed by Walter Dorwin Teague, designer of the fair's Ford Motor, U. S. Steel, National Cash Register, Eastman Kodak and du Pont "Wonder World of Chemistry" exhibits.

The Consolidated Edison building will occupy a ground space of 75,000 square feet in the fair's Means of Production Zone, fronting on an avenue which curves away from the Theme Center, the heart of the fair's main exhibition area. Nearby space will be occupied by the Edison Electric Institute, while at some distance the "Court of Flame" pylons will mark the gas utilities' joint display. Neighboring exhibitors will include the General Electric Company, whose "man-made lightning" laboratory should interest electricity devotees.

Ground for the Consolidated Edison exhibit was broken on March 10 when, at a signal from Mr. Carlisle, board chairman of the company and member of the fair's executive committee, the first 90-foot pile was driven into the Queens site. Consolidated Edison officials in charge of the system's fair activities include Clarence L. Law, executive assistant to the vice-chairman of the board; Harold S. Sutton, executive assistant to the chairman of the board, and Henry Obermeyer, assistant vice-president. Associated with them are Ray Martin, art director, advertising department, and A. W. Stark, engineer of commercial buildings, both of Consolidated Edison.

Missouri Association Convention

CHESTER C. SMITH, Kansas City, Mo., vice-president of the Kansas City Power & Light Company, was re-elected president of the Missouri Association of Public Utilities at its thirty-second annual convention April 20, 21 and 22 in St. Louis Mo. The Association membership comprises virtually all of the privately-owned electric, gas, and water companies in Missouri.

The other officers elected were: First vice-president, E. H. Lewis, St. Louis County Gas Company, Webster Groves, Mo.; second vice-president, Ben C. Adams, Gas Service Company, Kansas City, Mo.; third vice-president, O. F. Funk, Union Electric Company of Missouri, St. Louis; treasurer, Hermann Spoehrer, Union Electric Company of Missouri, St. Louis; secretary, N. R. Beagle, Missouri Power & Light Company, Jefferson City, Mo.; assistant secretary, Jesse Blythe, Jefferson City, Mo.; managing director, E. A. Beer, Jefferson City, Mo.

The following Executive Committee was elected: A. E. Bettis, Kansas City Power & Light Company, Kansas City, Mo.; Fred Karr, Gas Service Company, St. Joseph, Mo.; C. E. Michel, Union Electric Company of Missouri, St. Louis, Mo.; H. B. Newman, Missouri Utilities Company, Cape Girardeau, Mo.; L. W. Helmreich, Capital City Water Company, Jefferson City, Mo.; B. F. Pickard, Laclede Gas Light Company, St. Louis, Mo.; D. W. Snyder, Jr., Missouri Power & Light Company, Jefferson City, Mo.; T. J. Strickler, Kansas City Gas Company, Kansas City, Mo.

A Safety Meeting was held on the afternoon of April 20, under the auspices of the Safety Committee, of which A. A. Rall, Kansas City Power & Light Company, was chairman. An address was made by Joseph T. Davis, past president of the St. Louis Safety Council, followed by a round-table discussion of (1) accidents to employees, (2) accidents to the public, (3) general accidents.

A Get-together luncheon at noon, April 21, was addressed by Louis H. Egan, of St. Louis, president, Union Electric Company of Missouri. All available past presidents of the Association were seated at the head table as guests of honor, together with the present officers and Executive Committee. President Chester C. Smith presided and introduced the guests of honor.

Among the speakers on the program were: Walter C. Beckjord, New York City, vice-president of the American Gas Association; L. A. Hawkins, Schenectady, N. Y., Executive Engineer of Research, General Electric Company; Floyd W. Parsons, New York City, editorial director, *Gas Age;* Dr. G. W. Allison, New York City, Edison Electric Institute; A. A. Nichoson, New York City, manager of personnel, The Texas Company; A. P. Bender, Sharon, Pa., Westinghouse Elec. & Mfg. Company; Cleveland A. Newton, St. Louis, Mo., General Counsel, Mississippi Valley Association; F. M. Veatch, Kansas City, Mo., consulting engineer.

The annual dinner, sandwich spread and floor show, and entertainment program for the ladies were in charge of the Entertainment Committee, of which Paul C. Ford, Kansas City Gas Company, was chairman.

An Open Forum on the afternoon of April 22 discussed the subjects, "Selling the Small User" and "Customer Relations and Common Sense." Fred Karr, Gas Service Company, St. Joseph, Mo., was chairman.

The time and place of holding the 1939 convention will be selected by the Executive Committee at its meeting in September or October. Invitations have been extended from Kansas City, Excelsior Springs, and Joplin, Mo.

Maryland Association Meeting

R. C. Brehaut of the Washington Suburban Gas Company, has been elected president of the Maryland Utilities Association succeeding D. E. Stultz of the Potomac Edison Company, who is retiring to become a member of the board of directors.

Other officers of the group, elected at the annual meeting held in Baltimore April 29, are: W. D. Haley, Washington Suburban Gas Company, secretary; R. F. Bonsall, Consolidated Gas, Electric Light & Power Company, reelected treasurer; Joseph A. Stoll, Baltimore Transit Company, vice-president. Harold G. Haydon and R. L. Smith, Potomac Electric Power Company, and Lewis Payne, Eastern Shore Public Service Company, were re-elected directors; Harold Schell, Hagerstown Light & Heat Company, was elected a new board member.

At a meeting of the electric group of the association H. C. Thuerk, Utility Management Company, talked of "Distribution Factors to Be Considered in Selling the Profitable Load."

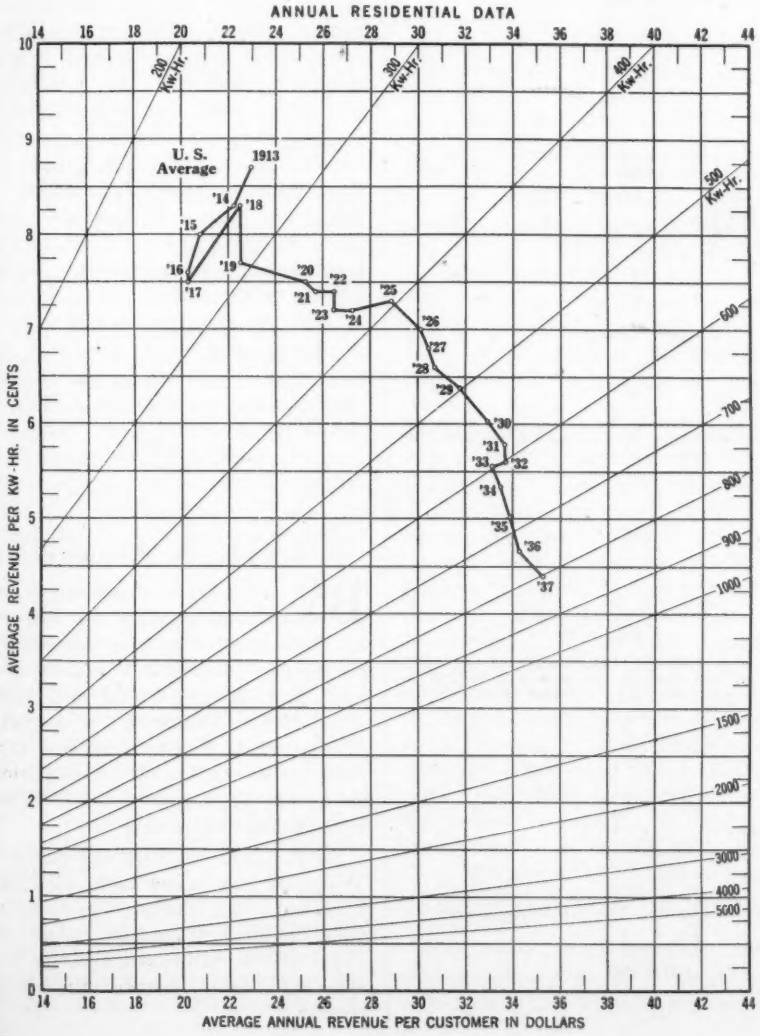
Domestic Sales—Average Rates, Use and Revenue Since 1913

THE E.E.I. currently publishes figures of sales of electric energy to domestic customers in the U. S. now numbering slightly more than 22,000,000. Data of sales to the average residential customer are also published for the years from 1913 to date (see Table 14, E.E.I. Statistical Bulletin No. 5). From 1926 to 1937 figures by months are also given for domestic customers (residential and farms in the eastern area of the U. S. See Table 26).

In plotting curves for average customer data on time-series charts, it is necessary to show three separate curves, (a) average kwhr per customer; (b) average bill per customer; and (c) average revenue per kwhr. Where these three curves are placed on a single chart, it is difficult to add additional curves for the comparison of individual company figures with the U. S. average.

In the drawing below is shown a composite of the three curves as a single curve with the time-series indicated from 1913 to 1937. The data are for the average "domestic" customer, as shown in Table 26 in Statistical Bulletin No. 5. The general trend of each of the three measurements may be easily read from this chart. The figures for the average customer of a single company or several companies may be plotted without difficulty to show relationship to the average customer of the entire industry.

The horizontal lines indicate that the average price per kwhr has dropped from 8.70c in 1913 to 4.70c in 1937, a decrease of 49.4 per cent. The diagonal lines indicate that the average use per customer increased from 264 in 1913 to 802 in 1937, an increase of 204 per cent. The vertical lines show that the average bill increased from $22.97 in 1913 to $35.29 in 1937, an increase of 53.6 per cent as compared with an average increase in kwhr or 204 per cent.



Hydraulic Power Committee

(*Continued from page 227*)

gave the procedure observed by Mr. Moore in converting an attended hydroelectric station to one which is unattended but not completely automatic. Mr. Moore included in his write-up an example of such a conversion involving a plant of comparatively recent construction typical of the period from 1920 to 1929. Plants of older design have also been converted to this control but each has been such a special case that the details are peculiar to only the particular location. The paper sets forth 16 essential points in regard to changed and added equipment and gives examples of an elementary wiring diagram which is essential in following the various operations. A regular switchboard wiring diagram is also presented which is necessary for the wiring installation.

Coordination of Governor Characteristics in Respect To Operation of Large or Interconnected Systems

A report on this subject was sent to the Committee by Mr. E. H. Collins, one of its members. This discusses experimental data relative to the proper coordination of both steam and hydro unit governors and frequency and tie line control on a large system. The following recommendations appear in the report:

1. For improved control the first step is to improve the old governors on the system to approach the degree of perfection attained by modern governors.

2. The functioning of the governors and automatic control equipment should be coordinated with respect to sensitivity, dead time, and properly proportioned rates of change of generator power outputs on the respective systems.

3. The methods of accomplishing these objectives are by increasing the sensitivity and decreasing the dead time of the governors by the elimination of friction and lost motion in the moving parts of the mechanism.

4. As many plants as practicable should be made to share the regulation, provided the governors can be made sensitive and their action coordinated as outlined above. Where this is impracticable and the plant is operated on fixed output, the governors should be blocked or adjusted so they are relatively inactive for ordinary speed changes but available as an emergency shutdown device or for large load fluctuations.

The Committee is now studying the coordination of governor action and a Subcommittee has been appointed to make a further report.

Don't Pass the Buck! Don't tell the customer "I've got nothing to do with it. That isn't in my department." If you tell him that, you're sure *not* to make friends with that customer. You know how it is yourself . . . when you have a complaint to make . . .

LINEMAN:
Now look . . . I bought some sox here last week, and they wore through the heels. I want a new pair for 'em.

CLERK:
Sorry, mister, complaints aren't in my department.

LINEMAN:
Oh, yeah? This is a swell kind of place . . . sell you bum sox and then tell you "that isn't in my department."

ANNOUNCER:
No, none of us like to run up against that sort of thing. Wouldn't it have been far better, like this . . . .

CLERK:
Sorry you had trouble with the sox. But if you'll just step over to the adjustment desk, two aisles over . . . (fading out)

ANNOUNCER:
That's the stuff. Let the customer know he's going to be taken care of.

Same with *our* customers. We want them to *know* that we're glad to correct any misunderstanding that arises, no matter who's at fault. So let's try it this way:

LINEMAN:
I'm sorry there's anything wrong about your bill, but I know the fellows down at the office will be glad to straighten it out. Why don't you drop in at our office and talk to them?

CUSTOMER:
Think they'll listen to me?

LINEMAN:
Sure they will. We don't want any of our customers dissatisfied with our service. They'll look after you down at the office.

CUSTOMER:
Well, that's fine. I'll do that.

CUSTOMER RELATIONS

A Series of Five Slide Films

THE Vocafilm Corporation, in consultation with the Edison Electric Institute and a number of practical operating executives representing properties all over the country, has prepared a series of five sound slide films on constructive customer relations designed primarily for showing at employee meetings.

Each film is designed to increase the efficiency, courtesy, and knowledge of employees. Five major problems common to all operating companies were selected and the answers posed in these five 15-minute sound slide films.

The films are directed to all those who come into contact with the public—meter readers, linemen, maintenance gangs, trouble shooters, engineers, switchboard crews, service men, cashiers, inspectors, telephone operators, information clerks, credit men and salesmen.

An excerpt from one of the films, both pictures and dialogue, is shown in the adjoining column. It is difficult in just a few pictures to show the extent of the treatment of any subject, for that which precedes and follows has a decided bearing on the subject.

The Western Newspaper Union, which has offices in 34 key cities, has these pictures and will be glad to show them to any electric company. Further details may be obtained from the Vocafilm Corporation, 424 Madison Ave., New York.

Rahn Heads Association

BRUNO RAHN, vice-president and general manager of the Milwaukee Gas Light Co., was unanimously elected president of the Wisconsin Utilities Assn. in the annual mail ballot voted by the Association's membership. He succeeds C. E. Kohlhepp, who as retiring president, becomes the chairman of the Advisory Committee. Mr. Rahn's term of office begins May 1.

A. P. Gale, executive vice-president, Wisconsin Power and Light Company, Madison, was elected vice-president. John Dockendorf, assistant research engineer of The Milwaukee Electric Railway and Light Company was elected treasurer.

Southeastern Electric Exchange Meeting

THE Southeastern Electric Exchange held its annual conference, April 21-23 at Edgewater Park, Miss., between Gulfport and Biloxi. Total registration exceeded two hundred by nearly twenty-five.

President W. E. Mitchell opened the conference. He reviewed the progress made by the Exchange during the year, reporting that membership was at its highest in the history of the Exchange. Employees of member companies now total over 30,000, he pointed out, and average sales per residential customer for the majority of the companies is in excess of 1,100 kwhr per year, and in a few companies over 1,300 kwhr per year, as compared with the national average of 807 kwhr per year.

Other speakers at the Thursday morning session were Senator Dudley Bagley, chairman, North Carolina Rural Electrification Authority; Harry Hoffman, chairman, Mississippi State Industrial Commission; Thomas L. Bailey, member of the Mississippi Legislature; and W. T. Anderson, editor, Macon, Ga., *Telegraph*. At the Thursday evening session, J. F. Owens, president, Oklahoma Gas and Electric Co., spoke on "Pioneering in the Electric Utility Industry," Bryan C. Hanks, president, Florida Power and Light Co., chose as his subject, "Men Like Our Mountains."

The Friday morning session was opened with a report from C. B. McManus, chairman, Engineering and Operating Section, and Charles C. Drummond, chief accountant, State Corporation Commission of Virginia, addressed the conference on "Public Utility Accounting Under Present Day Regulations." "Partners in Progress" was the title of an address by C. E. Wilson, executive vice president, General Electric Co., who followed Mr. Drummond. "Economic Planning for Public Utilities" was presented by Maurice Scharff, consulting engineer, New York City. The concluding address of the Friday morning session was a paper, "Planning System Development," prepared by E. C. Stone, vice president and general manager, Duquesne Light Co., and read by E. A. Hester of the same company.

One of the most enjoyable features of the conference was a banquet held Friday evening. Barney Eaton, president, Mississippi Power Company, presided as toastmaster and introduced the principal speakers: C. W. Kellogg, president, Edison Electric Institute, and P. S. Arkwright, president, Georgia Power Company.

Load building and selling was the keynote of the concluding session held Saturday morning. Following the presentation of section reports by H. E. Simpson, secretary-treasurer, Florida Power and Light Co., and S. P. Vecker, general sales manager, Carolina Power and Light Co., chairmen respectively of the accounting and sales sections, addresses were presented by O. M. Jackson, merchandise manager, Georgia Power Co.; Irving W. Clark, manager, kitchen planning, Westinghouse Electric and Manufacturing Co.; C. A. Eastman, Ebasco Services, Inc., and C. E. Greenwood, commercial director, Edison Electric Institute.

Officers elected were: President, Bryan C. Hanks, Florida Power and Light Co.; first vice president, Charles E. Ide, East Tennessee Light and Power Co.; second vice president, A. W. Higgins, Florida Power Corporation; and third vice president, J. A. Longley, Tennessee Electric Power Company.

Arkansas Association Meeting

SEVERAL hundred representatives of Arkansas utilities, gathered at the Eastman Hotel, Hot Springs National Park, on April 18 and 19 for the twenty-seventh annual convention of the Arkansas Utilities Association.

James Hill, Jr., president, Arkansas Missouri Power Corporation, Blytheville, Arkansas, and president of the association, opened the convention and presided over its sessions. Rex I. Brown, president, Mississippi Power and Light Company, Jackson, Mississippi, was the principal speaker at the general session held the first day. Mr. Brown's subject was "The Utilities and Dealers."

The first day's sessions were closed with a banquet and special entertainment. R. W. Carney, vice president, Coleman Lamp and Stove Company, Wichita, Kansas, was the principal speaker of the banquet, his subject being "The Master Salesman of the Ages."

Technical sessions for both gas and electric utility personnel were conducted concurrently. Among those who addressed the electric section were R. R. Pittman, Arkansas Power and Light Company, Pine Bluff, who spoke on "Four-Wire Three-Phase Common Neutral Systems"; F. J. Niblock, Arkansas Power and Light Company, Little Rock, "Modern Practices in Transformer Banking"; C. E. Bathe, Oklahoma Gas and Electric Company, Oklahoma City, "Radio Interference and Its Suppression"; and E. F. Graham, Southwestern Gas and Electric Company, Shreveport, La., "Why the Difference Between Residential and Commercial Rates."

New officers were selected at the concluding session. C. B. Wilson, state sales manager, Arkansas Louisiana Gas Company, Little Rock, was selected as president for the ensuing year. Others elected were: First vice president, A. R. Watson, Arkansas Utilities Company, Helena; second vice president, D. H. Thurston, El Dorado; and secretary-treasurer, R. E. Ritchie, Arkansas Power and Light Company.

The Middle West

(*Continued from page* 240)

one-half the number of residential meters in that locality. Lectures in this same city on Sight-Saving Lighting heard by an audience of over 601,000 people, a number equivalent to more than 50% of the population; over 900,000 pieces of literature distributed on residential Sight-Saving Lighting.

8. Improved public relations which have come as a result of the work of the well-trained and courteous home lighting advisors.

Question No. 10 "What do you predict will be your attitude and activities on Better Light-Better Sight in the future—from one to five years?"

Every company returning a questionnaire indicated that an aggressive lighting promotion would be continued. *Eleven* of these companies, or 40% of the total, plan to expand their present operations in the near future. This universal acceptance would indicate that the promotion and sale of Better Light for Better Sight has become a definite and permanent part of every operating company's new business activity.

Conclusion

The reports received indicate:

1. That the need for better lighting constitutes a rich potential market with almost unlimited possibilities.

2. That better lighting has been profitably sold during the past five years.

3. That operating companies will increase their appropriations for advertising, publicity and additional man-power to sell this market.

The Southeast

(*Continued from page 236*)

most satisfactory and thoroughly justified the activity.

During the five years of progress in the Better Light-Better Sight movement, many unusual and outstanding accomplishments have been made. Two striking examples might interest you—One utility selected a district with 5,400 domestic customers whose average kwhr consumption was only 446 in 1936 and concentrated the efforts of their home lighting advisers for six months in this district. They visited 90 per cent of the homes, assembling and leaving one of the paper trial lamps on each visit. A planned conversation was carried on while erecting the lamp. During 1936 the merchandise volume in this district was approximately $59,000. In 1937, this volume increased to approximately $131,000, and the average gain per customer in khwr increased to 42.9 kwhr compared to a gain of 15.6 kwhr the year previous.

Another utility with a total of 9,100 residential customers conducted a campaign on I.E.S. Study Lamps in the fall of 1935. A quota of 500 lamps was set for the ten-week period. They sold for $1.95, including a 150-watt bulb. In the first week of the campaign, the entire quota was sold. No lamps were left in stock. During the rest of the campaign period, no lamps were in stock 60 per cent of the time. During the last three weeks of the campaign a low-priced floor lamp was also featured. Results of the campaign: 2,150 lamps sold—428 per cent of quota! 23.5 per cent of the customers were sold. Wattage added was 339,800, and estimated annual revenue added was $10,914!

Any number of outstanding accomplishments have been made. But one pointed out by most utilities was the closer relationship gained between the utility and dealers and their acceptance of Better Light-Better Sight lighting equipment as standard merchandise.

A check on the sale of I.E.S. Lamps by southeastern utilities and dealers for the years 1934 through 1937 shows a rapid increase from year to year. In 1935 sales on the average doubled those of 1934. Again in 1936 sales on the average doubled those of 1935. In 1937 we find the sales curve sliding back in a few cases due to sensational sales in 1936 or to the business recession, but in other cases they continued to climb at the same rate of speed.

There can be little doubt that the Better Light-Better Sight activity in the Southeast has been an outstanding success. But, what about the future? Utility executives in the Southeast feel that the program has, not only been most successful during the past five years, but that it offers possibilities for even greater accomplishments in the future. Most of them feel that only the surface has been scratched, that such a program as the Better Light-Better Sight Program should of necessity be a permanent one and they are accordingly making plans to continue the activity on a comprehensive, aggressive basis. The high regard in which the program is held by southeastern utilities, as well as their hopes for the future, are well indicated by the following remarks of a utility executive—"We feel very enthusiastic about the entire Better Light-Better Sight activity in what it has enabled us to accomplish and even more with reference to future possibilities. This activity, to my mind, has been the greatest single coordinator of the electric industry on a national basis. You can feel assured of our continuous support."

The past five years have been five years of progress for the Better Light-Better Sight program in the Southeast! Five years of growth! Yes—five years of successful promotion—five years that furnish a sound foundation for greater advancement and success in the future.

CONVENTIONS AND MEETINGS

MAY

2-5	Chamber of Commerce of the U. S. A., Washington, D. C.
2-5	Engineering Committees, Edison Electric Institute, Edgewater Beach Hotel, Chicago, Ill.
9-13	National Fire Protection Association, Atlantic City, N. J.
15-20	National Electrical Manufacturers Association, Hot Springs, Va.
22-26	National Electrical Wholesalers Association, Hot Springs, Va.
23-26	National Association of Purchasing Agents, St. Louis, Mo.
26-27	Pacific Coast Electrical Association, Annual convention, San Francisco, Calif.
27-31	Westinghouse Agent-Jobbers Association, The Homestead, Hot Springs, Va.
31	Heating Piping and Air Conditioning Contractors National Association, Boston, Mass.

JUNE

1-2	Heating Piping and Air Conditioning Contractors National Association, Boston, Mass.
6-9	EDISON ELECTRIC INSTITUTE, Atlantic City Auditorium, Atlantic City, N. J.
20-24	American Institute of Electrical Engineers, Washington, D. C.
20-24	American Society of Mechanical Engineers, St. Louis, Mo.
21-24	Canadian Electrical Association, annual convention, Seigniory Club, Province of Quebec, Canada.

AUGUST

29-31	Illuminating Engineering Society, Nicollet Hotel, Minneapolis, Minn.
29-31	Rocky Mountain Electrical League, Canyon Hotel and Lodge, Yellowstone Park, Wyo.

SEPTEMBER

1	Illuminating Engineering Society, Nicollet Hotel, Minneapolis, Minn.
7-9	Pennsylvania Electrical Association, Bedford Springs Hotel, Bedford Springs, Pa.
12-15	National Electrical Contractors Association, Book-Cadillac Hotel, Detroit, Mich.
29-30	Indiana Electric Association, French Lick Springs Hotel, French Lick Springs, Ind.

OCTOBER

1	Indiana Electric Association, French Lick Springs Hotel, French Lick Springs, Ind.
3-6	American Transit Association, Toronto, Canada.
3-7	National Restaurant Association, Chicago, Ill.
10-14	American Gas Association, Atlantic City, N. J.
10-14	National Safety Council, Stevens Hotel, Chicago, Ill.
24-28	National Electrical Manufacturers Association, Palmer House, Chicago, Ill.